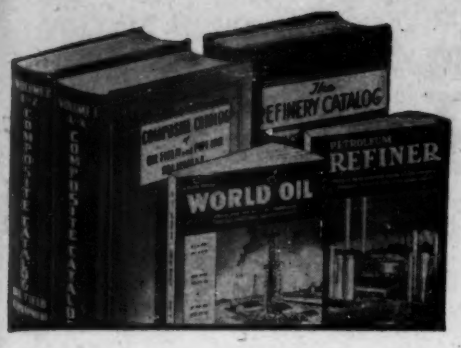

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for the refining-natural gasoline industry

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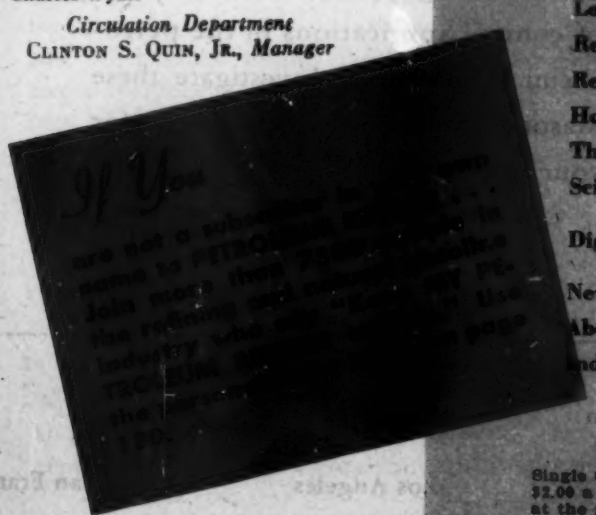

PETROLEUM REFINER

Specialized for the manufacturing division of the petroleum industry, refining, petrochemical processing, cycling and natural gasoline operations.

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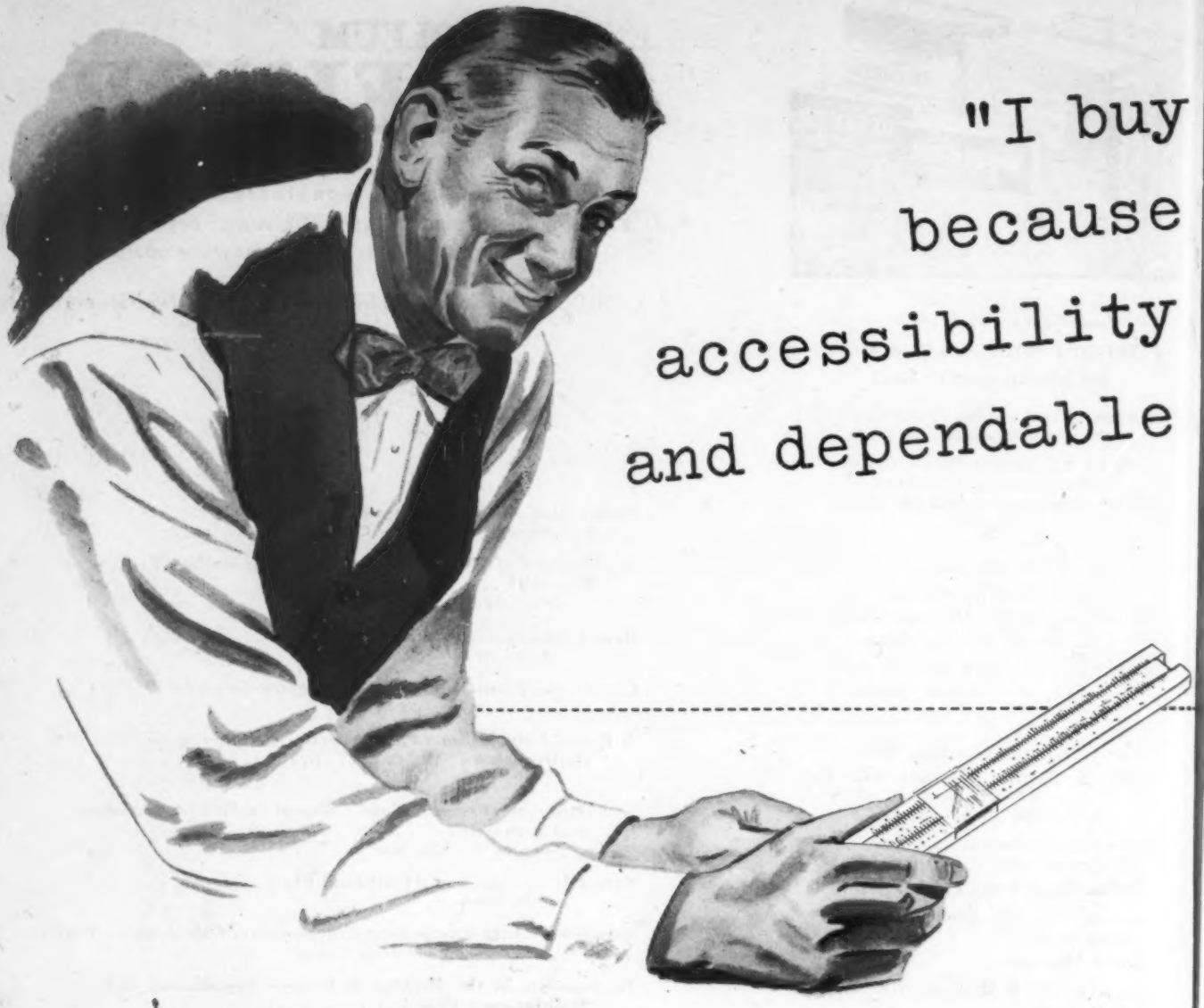

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Petrochemical Aid for Farms

ECONOMIC analysis groups concerned with the development of markets for synethetic organic chemicals in agriculture have reason for encouragement in the really remarkable results obtained in recent large scale commercial tests of weed killing chemicals and of soil fumigants.

The weed killer, 2,4-D, common term for 2,4-dichloro-phenoxy-acetic acid, is a plant hormone or growth stimulant. Its great advantage lies in that it kills broadleaved plants by over-stimulation whereas it leaves grasses and narrow-leaved plants unharmed. Tests also have proven that 2,4-D aids in the growth of narrow-leaved plants. The exact reasons for these phenomena are, as yet, unknown.

Another chemical, dichloropropane-dichloropropene, or just D-D, is a soil fumigant used in combating nematodes. Nematodes are microscopic animal organisms which cause knot-like growths on the roots of tomatoes, carrots, tobacco, pineapple, and other truck crops. Yields from the infested crops are poor. D-D, injected just below the surface of the soil often produces greatly increased crop yields which make the treatment economically feasible. This is peculiarly true with tobacco crops where both quality and quantity are raised.

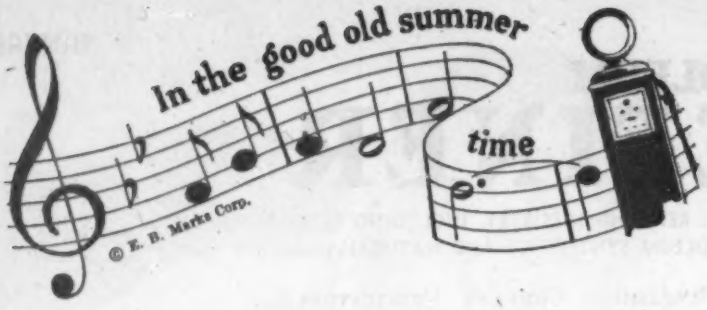
Modestly introduced to the public as a weed-killer to be used in combatting clover, dandelions and other small broad-leaved weeds that cause so much trouble to lawns and golf courses, 2,4-D first received large scale commercial application when an unusually long rainy season prevented farmers in a Kentucky area from cultivating their corn crop. Weeds shot high and grew with abandon. With nothing to lose and all to gain, the farmers of the area sprayed 2,4-D over 18,000 acres of condemned corn. The near-smothered corn thrived while the weeds wilted and died and at harvest yield increased as much as 18 bushels to the acre compared with results from ordinary cultivation methods. Roots of the treated corn were twice as long as the untreated corn, definitely proving the chemical's benefits. Cost of applying

Fuel for Future Engines

MARION E. DICE, manager of economics department of General Petroleum Corporation, in discussing supply and demand trends recently, noted that a shortage of some 100,000 barrels per day of petroleum products is indicated for California by the end of 1951, but stated no shortage would be allowed to develop.

His comment is worthy of note:

"The present liquid fuel industry has long since ceased to be a servant of crude oil, existing only for the utilization of one kind of natural resource. It is rather the servant of the machines which consume the fuels. We shall make the kind of fuels needed for the engines of the future and in the quantity needed without much regard to the source or nature of the raw material."

Evidently Dice has complete confidence in the technical abilities of our industry. As he is especially well informed in matters of economics, his statements, expanded to include more detail, were qualified by explanations of the cost factors which will control the rate at which any specific fuel source will come into general utilization.

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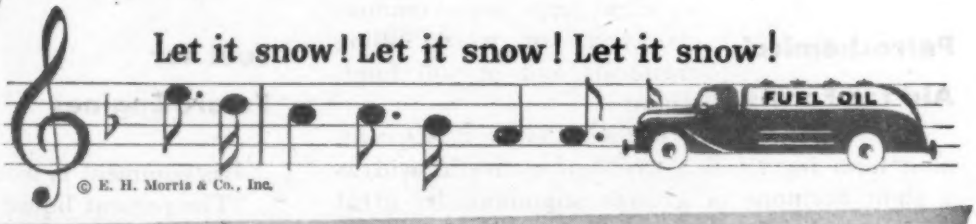

With TCC, you can vary your product distribution at will, according to seasonal demand. You can get optimum yields of motor gasoline in the summer, when it's hot. And in the winter, when it's not, you can get proportioned production of distillate heating oil.

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the 2,4-D was said to be only one-tenth the cost of cultivating the corn by hand, and the farmers were jubilant with the results.

Tests have also been made on small grains such as wheat, oats, rye and barley with corresponding success and wheat farmers of both Canada and the United States will compete with the corn grower for this useful chemical.

At best, the production of 2,4-D for the coming year will be enough to treat from 10 to 20 million acres. In 1947 some 84 million acres of corn were planted in the United States. Canadian farmers would like to treat 10 million acres of wheat, will probably get 2,4-D to treat only 5 million acres. Shortage of mono-chloro-acetic acid, basic material in the manufacture of 2,4-D and the great demand by the drug and plastic industry for the basic ingredients, phenol, chlorine, and acetic acid preclude a sufficient supply of the chemical to meet immediate agricultural demands.

Additional manufacturing facilities for the production of soil fumigants are currently under construction by one large petrochemical company. It seems quite certain that a rapidly growing market for chemicals in agriculture will result in a large expansion of our petrochemical processing plants.

DURING 1947 consumption of natural rubber exceeded synthetic for the first time since 1943, according to year-end reports by executives of major rubber companies.

Synthetic Rubber, National Problem

The position of our economy which synthetic rubber will occupy, now that prewar sources of natural rubber are again in volume production, is still not too clearly defined, but possibly can be roughly estimated from a consideration of past production figures and of anticipated consumption for 1948.

Predicted total consumption for 1948 is around 900,000 tons, which is more than any prewar year (35 percent higher than 1940), larger than any years except 1946 and 1947. About 350,000 tons of this total will be synthetic rubber, roughly 40 percent. In 1942, 96 percent of our rubber production was natural. In 1944 the wartime synthetic rubber plants came into their first large operation and consumption of synthetic rubber exceeded natural. In 1945, the part wartime year, synthetic rubber reached a peak of some 87 percent of our total use. In 1946 total consumption reached a new high of 1,039,000 tons, 73 percent of which was synthetic, and in 1947 this figure increased slightly to some 1,100,000 tons, with approximately 50 percent synthetic.

High production of tires during 1947 has to a large degree relieved the severe shortage which developed during the war years and it is expected that inventories will be filled in 1948 to the extent that backlogs for tires and for other rubber goods will be a less important factor in setting total demand. Although production of most rubber products in 1948 will equal or exceed that of 1947, tire production is expected to recede from an all time high of just under 100 million casings in 1947 to somewhat more than 80 million.

Important in maintaining the high demand for rubber will be the re-introduction of several products not widely available in recent years. Foam rubber, extensively used now in transportation fields, will be increasingly available for domestic furniture and mattresses. Output of lastex yarn in 1948 is expected to surpass prewar levels, and industrial rubber products will be made in large volume. Production of golf balls, bathing caps, and sundries has been facilitated by the return of natural rubber and will continue at high level. The re-introduction of style and color in rubber footwear has been a strong influence on demand, and this is expected to continue.

One development of especial interest to the petrochemical industry is the considerable production and marketing of new materials, "polyblends," in which either crude or synthetic rubbers are blended with various plastic materials to achieve end products having the better features of both rubber and plastics.

The past year marked the start of official congressional action on deciding policy as to the disposition of plants and facilities created to produce American rubber as a war measure. Meanwhile, as physical need for this rubber declined with the increasing availability of crude rubber from the Far East, activity in these plants was steadily cut back until, at the year's end, roughly half of the designed capacity had been shut down. There seems to be little disagreement as to the basic necessity that the nation's rubber reserves, represented by these rubber-making facilities, be kept at hand. It is in the working out of "ways and means" of retaining this protection most effectively, from the standpoint of the nation's economy as well as its defense, that differences arise.

John L. Collyer, president, The B. F. Goodrich Company, has outlined his company's viewpoints as follows: 1) Government participation in rubber making, as well as in allocating and other regulation, should be confined strictly to that area necessary to secure military security; 2) the facilities should be continually offered for sale or lease to industry, subject to conditions to be prescribed by the National Security Resources Board; and 3) wartime agreements for the exchange of technical information pertaining to man-made rubber should be terminated, in the interest of stimulating renewed private research and development.

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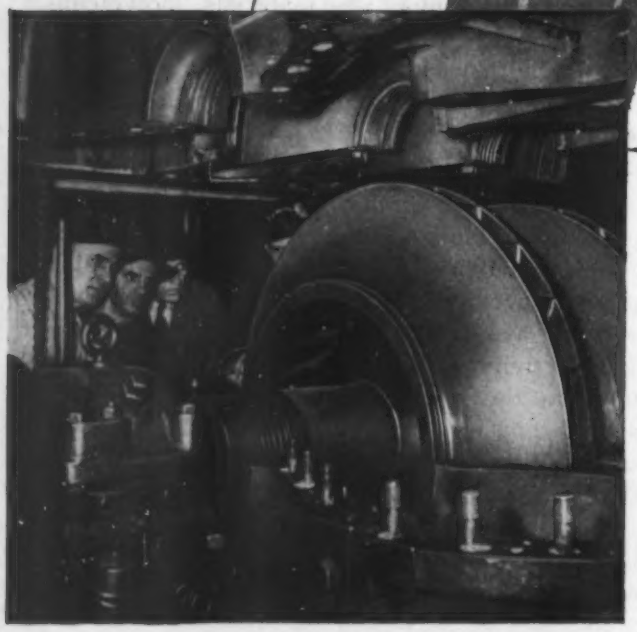

Elliott turbine-driven, three-stage centrifugal blower with upper half casing removed for routine inspection. The blower, rated 27,600 cu ft of air per minute at 17 psig, is driven by an Elliott 2200 hp steam turbine.

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Flange Design Considerations

HARALD E. LONNGREN, Mechanical Engineer, New York

THE author's stated object in this article is to put forth main influencing factors and to explain how each of them affects the flange design proper. Above all, the author attempts to erase some of the most pronounced misconceptions which have come to his attention. The most outstanding among these is the belief that the internal pressure alone is the main governing factor in all cases. Another common misconception resides in the belief that a flanged joint is improved by using a wider gasket than the specified one; also that the gasket material may be changed without affecting the characteristics of the joint. Furthermore, it is not uncommon to hear field men express the opinion that as long as a flange for corrosive service does not show any appreciable amount of corrosion on the face, the strength of it has not been impaired even if the hub portion has corroded twice as much.

In other words, most field men think of the strength of a flange in terms of its thickness and disregard the fact that it also takes a hub of a certain thickness to make a flange what it is supposed to be. Even a skilled designer cannot foretell what the actual stress distribution will be in a partly corroded flange. It is also difficult to make a layman fully understand that a tightened flange with a raised face is subjected to stressing without any internal pressure at all, that is, that the actual bolt load alone causes the flange to take on a certain thickness.

In this second article on flange design, the author presents a graphical method for finding the stress distribution in a flange which has been strengthened by the addition of material to provide for anticipated metal loss through corrosion or erosion. An earlier article dealing with stress distribution in integral type flanges appeared in the November, 1947, issue of *Petroleum Refiner*. Reference to this article is to be made for nomenclature used in the following discussion, and for certain flange design formulas.

THERE are several factors to be considered when designing an integral type flange. The influence of each one of these factors upon the ultimate shape and thickness of the flange is not fully appreciated by many engineers and men in the field.

First of all there are two definite and distinctly different design cases,

Case 1: The minimum required bolt load is determined by the load necessary to yield the gasket, that is, when

$$W_{MIN} = H_{GY} = \pi \times G \times b \times y$$

Case 2: The minimum required bolt load is determined by the load necessary to seat the gasket and to withstand the hydrostatic end force, that is, when

$$W_{MIN} = H_{GP} + H = \pi \times G \times 2b \times m \times p + .785\,G^2 \times p$$

It might be well to point out that the internal pressure plays an unimportant role in Case 1 whereas in Case 2 the influence from the internal pressure is pronounced.

Case 1

The most important influencing factor resides in the kind of gasket which is used, its width and material, also type of flange facing.

In the formula,

$$H_{GY} = \pi \times G \times b \times y$$

b = Effective gasket yielding width, that is, the width of the gasket upon which the unit load must be applied in order to yield the gasket.
y = Yield point of gasket material.
G = Mean gasket diameter.

The effective gasket yielding width varies with the type of facing used per Figure 1 and the yield point again is a function of the gasket material used per Figure 2.

Thus, as an illustrative example—if the gasket factors are

$$\left.\begin{matrix} b = .313'' \\ y = 4500 \end{matrix}\right\}$$ for 5/8" wide compressed asbestos gasket

the required minimum bolt load is

$$W_{MIN} = \pi \times G \times .313 \times 4500 = 4410 \times G.$$

and when

$$\left.\begin{matrix} b = .156 \\ y = 8000 \end{matrix}\right\}$$ ½" wide steel jacketed gasket with 1/8" nubbing.

$$W_{MIN} = \pi \times G \times .156 \times 8000 = 3925 \times G$$

This means that the former gasket requires about 1.123 times higher bolt load, which, in turn means that the flange must be thicker accordingly. It is thus

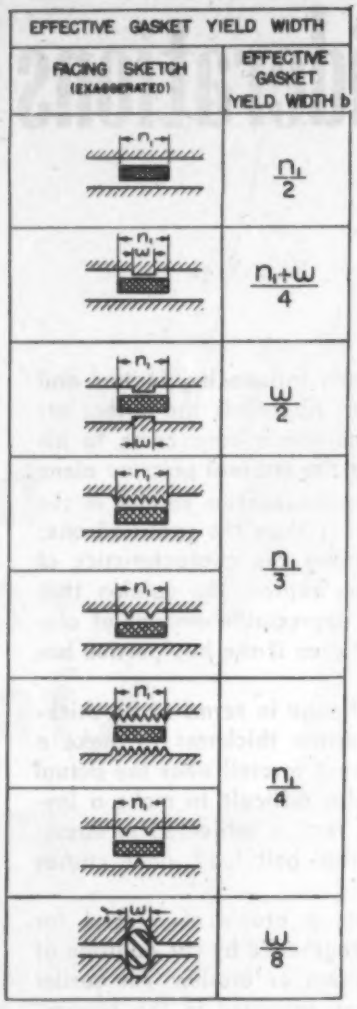

FIGURE 1

clear that the bolt load varies with the type and width of the gasket.

If the aforementioned gaskets are made wider, say ¼-inch, and the same mean gasket diameter is maintained, the required minimum bolt loads become,

Asbestos gasket: $W_{MIN} = \pi \times G \times .438 \times 4500 = 6190 \times G$ or 1.4 times greater.

Clad gasket: $W_{MIN} = \pi \times G \times .219 \times 8000 = 5500 \times G$ or 1.4 times greater.

Thus it is evident that the required bolt load should also be increased when the gasket is widened. For this reason it is imperative that only specified gaskets are used. No field man should have the authority to specify any other size gaskets.

Then, there is the question of the actual bolt load. In most instances this is made greater than the required minimum because it is not practical to space the bolts too far apart. There must be an adequate guarantee that the gasket actually will be yielded between the bolts, that is, that the bolt load is transmitted properly to the gasket. This can only be accomplished by adhering to past experience and thus to see to it that the bolts are spaced at about 3-inch centers when the size does not exceed 1¼ inches in diameter. This requirement will invariably result in an actual bolt load in excess of the minimum required. This excess should, of course, be kept at a minimum.

The flange design bolt load W is the average of the minimum required and the actual used, that is,

$$W = \frac{W_{MIN} + W_{ACT}}{2}$$

Case 2

The gasket material, width of the gasket and the flange facing affect the ultimate flange thickness in this case also, because the magnitude of the component part

$$H_{GP} = \pi \times G \times 2b \times m \times p$$

of the required minimum bolt load depends upon the gasket factors m and b. The hereinbefore mentioned considerations with respect to the width of the gasket hold true in this case also. The gasket compression factor m again varies also with the material of the gasket, as per Figure 2.

For the aforementioned illustrative example,

$m = 2.5 \quad H_{GP} = \pi \times G \times 2 \times .313 \times 2.5 \times p = 4.9\,G \times p$
$m = 3.5 \quad H_{GP} = \pi \times G \times 2 \times .156 \times 3.5 \times p = 3.63\,G \times p$

By widening the gaskets,

$H_{GP} = \pi \times G \times 2 \times .438 \times 2.5 \times p = 6.875\,G \times p$
$H_{GP} = \pi \times G \times 2 \times .219 \times 3.5 \times p = 4.8\,G \times p$

The H_{GP} component is increased 1.4 times in the first case and 1.3 times in the latter.

The bad effects from varying the gasket material and the width of the gasket are not so pronounced in this case because the H_{GP} component is ordinarily only a fraction of the H component. However, specified gaskets should always be used.

The other component H of the minimum required bolt load W is pretty well fixed and there is not much a designer can do in order to keep it down.

Flange Moments

For an integral type flange having the hub integral with the vessel wall, the lever arms are

$$h_D = R + \frac{g_1}{2}$$

$h_T = \frac{1}{2}(R + g_1 + h_G)$
$h_G = \frac{1}{2}(C - B)$

Case 1

The flange loads are

$H_D = .785 \times B^2 \times p$
$H_T = .785\,(G^2 - B^2) \times p$
$H_G = W - .785 \times G^2 \times p$

In this case it means that the H_D load is smaller than the H_G load. There is nothing a deisgner can do in order to bring down the M_D moment in a

FIGURE 2

GASKET MATERIAL		Factor M	Factor Y
Rubber Sheet	.....	.5	500
Cloth Inserted Rubber	.....	.75 1.0	750 1000
Compressed Asbestos	.....	2.5	4500
Spiral Wound Metal, Asbestos Inserted	.....	2.5	4500
Corrugated Metal Jacketed, Asbestos Filled	.....	3.0	6000
Corrugated Metal	Copper Monel Steel	3.0 3.25 3.25	6000 7000 7000
Metal Jacketed Asbestos Filled	Copper Aluminum Steel Iron Monel	3.0 3.25 3.5 3.5 3.5	7000 7000 8000 8000 8000

proposed flange. However, a conservative value of g_1 can be used in this case because the longitudinal hub stress will not be the governing one. A smaller value of g_1 lessens the h_D lever arm.

Thus in this case it will be seen that the H_G load is the greatest. In an effort to keep this load as small as possible, it is advisable to keep the flange design load down to a minimum. The resulting M_G moment can be lowered by keeping the h_G value (lever arm) as small as possible, that is, by placing the gasket as closely to the bolts as possible.

Case 2

The outstanding feature in this design case resides in the fact that the H_D load is governing. As this load is mostly absorbed by the hub it is advisable to use a fairly liberal value of g_1. The benefit from varying the mean diameter of the gasket is small. However, for very high pressures it will prove to be beneficial to keep this diameter as small as possible.

A fairly good estimate of the most favorable mean gasket diameter can be had in the following manner,

In this case

$W = H_{GP} + H$ ($= W_{MIN} = W_{ACT}$ for practical purposes).

$$H_G = W - H$$

or

$$W = H_G + H$$

Thus, $H_G = H_{GP}$ (practically)

Moment M_G,

$M_G = H_G \times h_G$ (should be the least)

$= H_{GP} \times h_G$ (practically)

Flange load $H_{GP} = \pi \times G \times 2b \times m \times p$

For a given design,

(w = width of gasket)

$G_{MIN} = B + w$

$G_{MAX} = (C - d) - w$

and

$h_{G\,MAX} = C - (B + w)$

$h_{G\,MIN} = d + \frac{w}{2}$

Thus,

$$\left.\begin{aligned}(B + w) \times [C - (B + w)] &= H_G = H_{GP} \\ [(C - d) - w] \times \left(d + \frac{w}{2}\right) &= H_G = H_{GP}\end{aligned}\right\} \text{ Practically}$$

For identical values of (2b m p).

By using the smaller value of these expressions it will be found if the M_G moment can be brought down by varying the mean diameter of the gasket.

After thus having carefully considered all the hereinbefore mentioned influencing factors the designer finally arrives at a certain total moment $M_O = M_D + M_T + M_G$ in the flange. In the following calculation steps he uses the value $M = \frac{M_O}{B}$, however, for the sake of simplicity. The work thus far done by the designer represents only the ground work and he must then proceed to determine the flange thickness which, together with the shape and size of the chosen hub (whether of tapered or straight contour), will make the flange as such capable of withstanding the load imposed upon it.

For this purpose the designer uses the following formulas,

$$\left.\begin{aligned}S_H &= \frac{M}{L} \times \frac{1}{g_1^2} \\ S_R &= \frac{M}{L} \times \frac{\beta}{t^2} \\ S_T &= \frac{MY}{t^2} - Z\,S_R\end{aligned}\right\} \text{ Per the ASME-API Code.}$$

in which M and g_1 have thus far been determined by him. The factors Y and Z are then found from chart in the code. This information represents the basis upon which the designer must keep on working. It is therefore very important that the choice of the value of g_1 is proper.

A layman ordinarily thinks of a flange in terms of its thickness only. He does not realize that the thickness of the hub at the back of the flange has a lot to do with the flange thickness proper. In order to be able to compare one flange with another for the same purpose, it is furthermore necessary to know the actual stress distribution in the flanges. In one flange it might be the longitudinal hub stress which is governing and in the other the radial or tangential flange stress. Only actual calculations can tell the real story. The thumb rule cannot be applied. Even a skilled designer could not possibly speak without first doing some figuring.

In flange design work it becomes highly desirable to determine a preferred stress distribution beforehand. This can best be done by glancing at the existing moments in the flange. If the M_D moment is by far the greatest a designer realizes that the thickness of the hub—g_1—at the back of the flange should be ample because the hub must absorb the bulk of the load. For this reason it is also desirable to allow the maximum permissible stress in the hub. If the M_G moment on the other hand is the greatest, the flange proper will be loaded more than the hub and this calls for a thicker flange. In order to properly design the flange for this case of loading it becomes desirable to allow for a higher radial stress in the flange.

The ASME-API code permits the designer to choose his own stress distribution in as much as it prescribes that,

$$S_H = 1.5\,S_F$$

$$S_R = S_T = S_F$$

and

$$\frac{S_H + S_R}{2} = S_F$$

$$\frac{S_H + S_T}{2} = S_F$$

Supposing that the designer has decided that it will be advantageous to use the maximum allowable stress in the hub, say in this case, $1.5 \times 15{,}000 = 22{,}500$ psi ($S_F = 15{,}000$). Because of the requirements $\frac{S_H + S_R}{2} = S_F$ and $\frac{S_H + S_T}{2} = S_F$ he thus must see to it that neither S_R nor S_T becomes larger than 7500 psi. The derivation of this is as follows:

$$S_H = 1.5\,S_F$$

$$S_F = \frac{1.5\,S_F + S_R}{2}$$

$$S_R = .5\,S_F = S_T$$

On the other hand if the designer has judged that the radial flange stress should be the highest permissible ($S_R = 15{,}000$ psi) he cannot allow more than 15,000 psi also in the hub. That is,

$$\frac{S_H + S_R}{2} = 15{,}000$$

$$S_H = 30{,}000 - 15{,}000 = 15{,}000 \text{ psi}$$

That each stress distribution case will give altogether different answers for the flange thickness is thus quite natural. Herein resides another good reason why two flanges for the same purpose will not

take on the same proportions when they have not been designed by the same man.

An important advantage of determining the most suitable stress distribution before attempting to calculate the flange thickness for a given case resides in the feasibility of arriving at an answer in a very quick manner—not only to the question of what the flange thickness should be with the anticipated value of g_1, but also to the question whether this g_1 value actually is suitable for the flange, that is, if the flange will be the most economical.

Thus, as an example:

$S_R = .5\ S_F$

$S_H = 1.5\ S_F$ that is, $S_R = \frac{S_H}{3} = S_T$

Thus,

$$\frac{1}{3} \times \frac{M}{L} \times \frac{1}{g_1^2} = \frac{M}{L} \times \frac{\beta}{t^2}$$

$$\beta = \frac{t^2}{3 \times g_1^2}$$

Per the Code

$$\beta = 1.33 \frac{F}{\sqrt{B \times g_o}} \times t + 1$$

Thus,

$$\frac{1}{3 g_1^2} \times t^2 = \frac{1.33\ F}{\sqrt{B \times g_o}} \times t + 1$$

or

$$t = \frac{1.995 \times F \times g_1^2}{\sqrt{B \times g_o}} + \sqrt{\frac{\left(\frac{3.99 \times F \times g_1^2}{\sqrt{B \times g_o}}\right)^2}{4} + 3 g_1^2} \quad (1)$$

The factor F can readily be taken from available chart when the $\frac{g_1}{g_o}$ and $\frac{h}{h_o}$ values are known, that is, when the designer has determined the shape of a hub of a flange which he believes to be suitable for a vessel having an inside diameter = B and a wall thickness = g_o.

With the aid of formula (1) he thus can quickly determine the very thickness of the proposed flange, which thickness will bring about the desired stress distribution. That is, as soon as the designer establishes the value of g_1 he has, in fact, also limited himself to a certain thickness of the flange. It is up to him to decide what the magnitude of the actual stresses will be for a given case when he also has worked out the magnitude of the prevailing total moment M in the flange. This moment can in no case be higher than the very moment which can exist in the flange having the thickness per formula (1). This maximum allowable total moment M can be found from equation,

$$M = \frac{t^2 \times S_H (Z + 1)}{3\ Y}$$

for this particular stress distribution case.

This equation emerges from the following consideration,

$$\frac{1}{3} \times S_H = S_R = S_T$$

$$\frac{MY}{t^2} - Z\ S_R = \frac{M}{L} \times \frac{\beta}{t^2}$$

$$\frac{MY}{t^2} - Z \times \frac{1}{3} \times \frac{M}{L} \times \frac{1}{g_1^2} = \frac{M}{L} \times \frac{\beta}{t^2}$$

$$\beta = \frac{t^2}{3\ g_1^2}$$

$$\frac{MY}{t^2} = \frac{M}{L \times 3 g_1^2} (Z + 1)$$

$$t = \sqrt{\frac{3\ Y\ L\ g_1^2}{Z + 1}}$$

$$L = \frac{M}{S_H\ g_1^2}$$

$$\text{thus, } t = \sqrt{\frac{3\ Y\ M}{S_H\ (Z + 1)}}$$

$$\text{or } M = \frac{t^2 \times S_H \times (Z + 1)}{3\ Y} \text{ as above}$$

For an integral flange with a straight hub the factor F = .9089 and formula (1) for t becomes,

$$t = \frac{1.813 \times g_1^2}{\sqrt{B g_1}} + \sqrt{\frac{\left(\frac{3.626 \times g_1^2}{\sqrt{B g_1}}\right)^2}{4} + 3 g_1^2} \quad (2)$$

For a flange of this type it will thus be readily seen that the flange thickness is actually governed by the value of g_1 as mentioned hereinbefore when $S_R = \frac{S_H}{3}$.

For corrosive service it is customary to add a certain "corrosion allowance" to the hub and flange face after they have been dimensioned for "corroded" conditions. This allowance is the same for both the hub and the face, ordinarily. This means that the actual stress distribution will be different, the magnitude of the difference being dependent upon the chosen stress distribution in the corroded flange, as calculated. This is best illustrated by an example.

For the sake of simplicity let us consider an integral flange with a straight hub.

Conditions when new (corrosion allowance added):

B = 26½" = inside diameter of the flange

g_1 = 1" = thickness of hub at the back of the flange.

$S_R = \frac{S_H}{3}$

$$t_{new} = \frac{.6038 \times 3 \times 1}{\sqrt{26.5 \times 1}} + \sqrt{\frac{\left(\frac{1.2076 \times 3 \times 1}{\sqrt{26.5 \times 1}}\right)^2}{4} + 3 \times 1}$$

$t_{new} = 2.125"$

Stress case:

$S_R = S_H$

$$t_{new} = \frac{.6038 \times 1 \times 1}{\sqrt{26.5 \times 1}} + \sqrt{\frac{\left(\frac{1.2076 \times 1 \times 1}{\sqrt{26.5 \times 1}}\right)^2}{4} + 1 \times 1}$$

$t_{new} = 1.132"$

These thicknesses of the flange are plotted in Figure 3, as ordinates with the values of n ($n_{max} = 3$, $n_{min} = 1$) as abscissas.

Condition when corroded

B = 27"

g_1 = ¼"

$S_R = \frac{S_H}{3}$ ∴ n = 3

$$t_{corr} = \frac{.6038 \times 3 \times .563}{\sqrt{27 \times .75}} + \sqrt{\frac{\left(\frac{1.2076 \times 3 \times .563}{\sqrt{27 \times .75}}\right)^2}{4} + 3 \times .563}$$

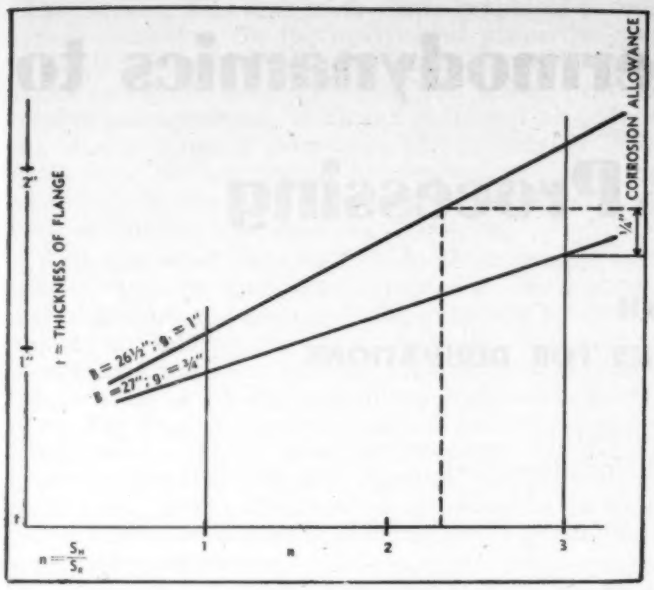

FIGURE 3

$t_{corr} = 1.546''$

$S_H = S_R \therefore n = 1$

$$t_{corr} = \frac{.6038 \times 1 \times .563}{\sqrt{27 \times .75}} + \sqrt{\left(\frac{1.2076 \times 1 \times .563}{\sqrt{27 \times .75}}\right)^2 + 1 \times .563}$$

$t_{corr} = .84''$

These values of t are also plotted in Figure 3.

From Figure 3 it will thus be seen that the thickness of an integral type flange with a straight hub depends entirely upon the chosen way of distributing the stresses in it—the minimum flange thickness in this particular instance being 1.132 inches and the maximum 2.125 inches, "when new," that is, when ¼-inch corrosion allowance has been added to it. For corroded conditions the respective thicknesses are .84 inch minimum and 1.546 inches maximum.

Now, if the .84-inch minimum thickness is sufficient for the prevailing total moment in the flange when corroded, then the actual thickness, when new, will be .84 + .25 = 1.09 inches which corresponds fairly well to the minimum thickness as calculated for "new conditions" for a stress distribution equal to $S_R = S_H$ or $n = 1$. This means that the original stress distribution in the flange is not disturbed.

If, however, the total moment in the flange calls for the thickness of 1.546 inches when corroded it will be necessary to design the flange for a stress distribution of $S_R = \frac{S_H}{3}$, that is, $n = 3$.

By adding the ¼-inch corrosion allowance to this, the flange thickness "when new" becomes 1.796 inches, that is, .33 inch less than the minimum called for. This means that the actual stress distribution will be different in the flange when new. The correct actual stress distribution is found in the following manner:

In Figure 3 draw a horizontal line through the point which represents the actual flange thickness "when new." The intersecting point between this line and the calculated flange thickness line will indicate the actual value of n, which in this case, is equal to approximately 2.2. Thus, in this case $S_R = \frac{S_H}{2.2}$, that is, actually the radial flange stress will become higher.

Flanges with tapered hubs can be investigated in a similar manner.

Conclusions

It will thus be seen that flange design work requires special training and skill. A flange designer must not only know how to perform the various calculation steps—he must also know the characteristics of the materials which are used. Thus, for instance, he must realize that the bolt load will penalize the flange at high temperature levels in particular. This is namely so because the bolt material maintains a high strength at elevated temperatures whereas the strength of the flange material drops sharply with the temperature.

As far as the author is aware there is no prior disclosure of a graphical method which illustrates the stress distribution in an integral type flange. It is hoped that designers will find this new method of great help in their work.

Another article by Harald E. Lonngren,
"Bolted-on Cover Plates—Flat and Dished-Design Calculations"

Applications of Thermodynamics to Hydrocarbon Processing

Part VII

HYDROCARBON PROPERTIES FOR DERIVATIONS

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THERMODYNAMIC process design tools; i. e., charts, tabulations and equations giving enthalpies, entropies, compression coefficients, fugacities, activity coefficients, heats of reaction, free energies of reactions, etc., are derived by applying the fundamental relationships to experimentally measured properties of hydrocarbons, such as: vapor pressures, densities, critical constants, specific heats, heats of vaporization, etc.

The technique of developing these tools by combining the theoretical equations and the experimentally found properties represents one of the most important applications of thermodynamics.

In general, the procedure followed in process design applications of thermodynamics is: 1) experimental data are obtained and correlated; 2) tabulations and charts are derived and thermodynamic properties are developed; 3) the correlated experimental and derived thermodynamic properties are applied to the problem.

The experimental data required in computing thermodynamic properties of hydrocarbons include: a) *volumetric* data, i.e., pressure-volume-temperature measurements, including densities, vapor pressures and critical data; b) *calorimetric* data, i.e., specific heats, latent heats of fusion and vaporization, heats of combustion and formation; c) *thermal coefficients*, i.e., Joule-Thomson coefficients and the isothermal effect of pressure on enthalpy; and d) *phase equilibria* data, i.e., the amounts and composition of the equilibrium liquid and vapor at various temperatures and pressures.

Considerable work has been done on determining these experimental properties of hydrocarbons. Considerably more must be done to improve these thermodynamic methods, particularly for hydrocarbon mixtures. It is important to realize that an imaginative application of the methods of thermodynamics to experimental data can make a few data go much farther. Thermodynamic methods are used to correlate the experimental data and extend their range as well as interpolate and check the data for accuracy by means of correlations.

Correlation and Derivation Methods

There are different styles or techniques used in correlating the experimental data and developing the charts and tabulations. The method used depends upon: a) the desired accuracy, b) the type of design calculation for which the particular chart is being developed, c) the experimentally measured properties of the fluid available, and d) the preference and skill of the engineer developing the tables and charts.

IN THE preceding six installments of this series the basic concepts of thermodynamics have been presented, fundamental equations have been developed and this theoretical foundation has been illustrated with examples on the perfect gas and simple non-hydrocarbon fluids. With this background, the development of thermodynamic tools for hydrocarbon process design may proceed.

Graphical or analytical methods may be used to correlate the data and to make the derivations from these correlations. Reduced dimensionless units (i.e., actual value of property divided by value of same property at the critical point) or actual dimensional units (metric or engineering) may be employed in these thermodynamic derivations.

It is not possible to make a hard and fast rule to be followed in selecting the methods for any given conditions. However, a few generalizations can be made from experience. When a single pure component, such as steam, is the fluid in question and where precise tables and charts are required, an equation of state is fitted to the volumetric behavior data and this equation used to compute the thermodynamic properties. It is customary to check the equation of state derivations by computing properties that can also be measured, such as Joule-Thomson coefficient, etc., and comparing the derived with the measured results.

Where several pure and similar fluids or mixtures, such as hydrocarbons and petroleum fractions, are the objects of thermodynamic study, or where the accuracy requirements are not so rigorous, generalized functions are employed to reduce the amount of work. In this method the volumetric data are correlated in terms of reduced and dimensionless units. These correlations are usually graphical rather than analytical, the thermodynamic properties being developed from these reduced generalized correlations by graphical differentiation and integration.

When the fluids involved are hydrocarbon mixtures the method employed in developing thermodynamic tools may be graphical or analytical. With either method, the system may be treated as an average equivalent fluid that behaves like a single component in the one-phase region and like a mixture in the two-

phase region. Likewise, with either graphical or analytical technique, the thermodynamic properties may be found by summing up the individual component properties (weighted for proportions), including heats of mixing and unmixing. With the analytical procedure, the thermodynamic properties of hydrocarbon mixtures may be formulated by derivations involving summing up the individual component equation of state constants, weighing the values, etc.

Both analytical and graphical methods may be used with reduced or generalized properties. For computing enthalpies and entropies, the graphical procedure applied to reduced volumetric behavior data results in sufficient accuracy for practically all process design calculations on single and mixed hydrocarbon systems. For fugacity-activity coefficients, on the other hand, more precision is often necessary, which may involve using the analytical equation of state method or, at least, giving more special attention to the individual components than is possible by the generalized graphical computations.

In this series of articles more attention will be given the generalized-graphical methods than the individual analytical methods because of the complex nature of petroleum. It is not always possible to treat a hydrocarbon mixture or a petroleum fraction as one component rather than a mixture of many components but this can frequently be done with a great saving in calculation time. In phase and reaction equilibria computations, it is almost always necessary to work with individual components.

Hydrocarbon Fluids

The complex nature of petroleum and the multitude of components encountered in any hydrocarbon processing operation makes the identification, classification and characterization of the individual hydrocarbons and petroleum fractions more than just a necessary preliminary to the applications of thermodynamic to measured physical and thermal properties in the development of design tools. There is usually a choice of several correlating variables when working with hydrocarbon mixtures and petroleum fractions.

Hydrocarbons differ as to their physical and thermal properties. Molecular weight and structure are sufficient to identify the hydrocarbons, which range from light gases to waxes and asphalt. Hydrocarbons are classified according to the type formula, as will be discussed later, and also by the product or fraction in which they occur. Another way of classifying hydrocarbons is by the type of thermodynamic treatment that must be employed. For example, light gases may be handled component-wise from a component analysis or breakdown. This would not be practical for a lubricating oil or a fuel oil. Where component breakdowns can be readily made and the mixture boils too low to fit empirical correlations and sufficient calculating time is available, the thermodynamics will be applied to the individual hydrocarbons. Petroleum fractions that cannot be broken down conveniently are handled as one fluid, making the phase behavior calculations to get the temperature (or pressure) change during vaporization.

For convenience, and simplicity, the terms "hydrocarbon mixture" and "petroleum fraction" will be used to designate different fluids, the distinction being boiling point. A "petroleum fraction" is a mixture of higher boiling hydrocarbons and is too complex to identify as to actual components. On the other hand, a "hydrocarbon mixture" is not always a "petroleum fraction."

The border line between "hydrocarbon mixtures" and "petroleum fractions" is arbitrary and indistinct. Usually this dividing line is in the gasoline boiling range between butane and hexane or between heptane and nonane depending upon the method of fractional analysis used. The divisions between gasoline, kerosine and gas oils and the characteristics of these fractions are defined in terms of the empirical ASTM (or Engler) laboratory distillations run at atmospheric pressure. Vacuum distillations and viscosities are used for lube and fuel oils. Thus, the application of thermodynamics to hydrocarbons and petroleum fractions is complicated and varied by the different characterizing and correlating methods that must be used.

Types of Hydrocarbons

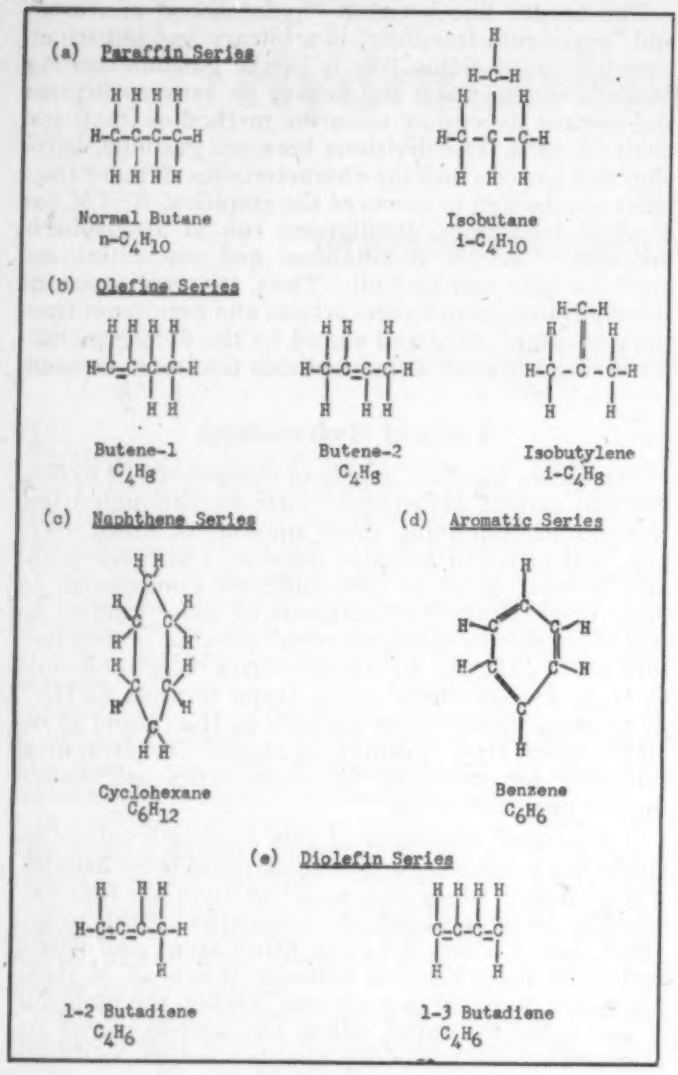
Petroleum consists largely of compounds of hydrogen and carbon, called hydrocarbons, although a few compounds containing small amounts of sulfur, oxygen, and nitrogen are also present. There are probably a total of about 3000 different components in petroleum. Those hydrocarbons of most interest in this series may be classified as: a) paraffin series (type formula $C_n H_{2n+2}$), b) olefin series (type formula $C_n H_{2n}$), c) naphthene series (type formula $C_n H_{2n}$), d) aromatic series (type formula $C_n H_{2n-6}$), and e) diolefin series (type formula $C_n H_{2n-2}$). The structural formulae for examples of these types are shown on the page following.

A thorough treatment of this subject involves introducing valences. For the purposes of these articles, it is sufficient to say that a carbon atom has four valences or hooks with which it can attach itself to another carbon atom or to any other atom, and that a hydrogen atom has one valence. When all of these hooks are attached in a normal fashion, the molecule is said to be saturated. When two carbon atoms are attached by two hooks or a double bond, the molecule is unsaturated. Paraffins and naphthenes are saturated while olefins, aromatics and diolefins are unsaturated molecules.

When the carbon atoms in the paraffin series hydrocarbons are linked together to form a straight chain, the hydrocarbons are called "normal" paraffins. If, on the other hand, the carbon atoms are arranged so as to form a branched chain, the resulting hydrocarbon is isomeric. The simpler the hydrocarbon, i.e., the fewer number of carbon atoms in the molecule, the fewer possible locations for this branch. For the more complex molecule, it is possible to have two or more branches at numerous locations. The number of possible isomers increases rapidly with increase in the number of carbon atoms.

Isomers are also possible in the olefin series. There is another variation in the olefin series, and that is the location of the double bond. The more carbon atoms in the molecule the more possible locations for the double bond. The naphthene and the aromatic series hydrocarbons are cyclic, i.e., the carbon atoms are connected to form a cycle. For the naphthene series, the ring may have any number of carbon atoms in its ring, those having 3, 4, 5, 6, and 7 having been isolated. The ring for the aromatic series is called the benzene ring and always consist in 6 carbon atoms

with every other bond a double one. The structural formulae are given below for an example of each hydrocarbon series.



Structural Formulae of Hydrocarbons

The physical and thermal properties of the hydrocarbons in these different series are somewhat different. The variation of these properties with temperature and pressure will be discussed, developed and presented in tabular and graphical form. Space and time do not permit a completely thorough treatment of the properties of hydrocarbons. Several references are included in the discussion so the reader may study further by looking up these and other references.

In presenting this subject many correlations will be included for illustrations. Where possible, these charts and tables will be precise and usable. In some cases, the charts will be for illustrations only.

Characterization of Petroleum

The different types of hydrocarbons occur in petroleum in varying proportions. It is not practical to attempt to give the percentage of each for different cuts, although this knowledge is valuable and exploratory work along these lines has been under way at the various laboratories. Accordingly, arbitrary characterization scales, employing two properties of the hydrocarbons, have been proposed and are being used.

The properties that have been used to characterize hydrocarbons and petroleum are: a) gravity, b) boiling point, c) viscosity, and d) aniline point, the gravity and boiling point being the most widely used. Gravity can always be measured and is important to the weight balance computations. Accordingly, all correlation methods use the gravity.

Boiling point, on the other hand, is not readily obtainable for a heavy lube or a fuel oil so viscosity or aniline point may be used instead of the boiling point. In some cases, such as diesel fuel oil, the aniline point has more meaning than either boiling point or viscosity.

Linking gravity with boiling point, viscosity, or aniline point gives characterization factors that may be used in correlating thermal and physical properties. These characterization factors are not sufficient in themselves to correlate molecular weight, critical conditions, etc., of petroleum fractions. This means that another or one of the characterization factor properties must be used as well.

In most of these cases, it is possible to use the original properties (like gravity and boiling point) directly, bypassing the characterization constant. There are exceptions to this however. For example, it is helpful to know the characterization is nearly the same for all the components and fractions, because then the characterization constant for a given crude may be found once and used where no boiling point, viscosity, or aniline point information are available for the individual fractions.

For example, the Watson and Nelson[11] (UOP) characterization factor is a function of gravity and average boiling point. This characterization factor was used with average boiling point by Watson and Nelson to correlate molecular weight of petroleum fractions. Likewise, Kay[8] used this UOP K factor with molecular weight to correlate pseudo-critical constants. In both of these instances it is possible to correlate the dependent property directly with the independent properties without going through the intermediate characterization factor. This more straight method of correlating hydrocarbon properties will be illustrated later.

Of the above mentioned correlating variables, the one most frequently used (beside gravity) and at the same time most subject to errors is the *boiling point.* For pure components there is no confusion as to the definition and determination of the boiling point but for hydrocarbon mixtures and petroleum fractions, where average boiling points must be used, there are possibilities for errors. For this reason, it is appropriate to discuss boiling points for mixtures.

Average Boiling Points

Boiling point characteristics of petroleum fractions are normally defined by the results of one of two standard laboratory distillation operations, the ASTM (or Engler) and the TBP (true boiling point) methods. The ASTM (American Society for Testing Materials) method approximates true differential distillation, i.e., batch distillation at a uniform rate with no reflux. Adjacent cuts from an ASTM distillation overlap considerably and contain many components in common. A TBP distillation gives a fractional analysis of individual components in the order of their boiling points with no overlapping of adjacent cuts. The TPB distillation curve for the lower

boiling hydrocarbons, which is determined by the Podbielniak method, is a series of plateaus as a result of the gaps in boiling points of adjacent components. At higher boiling points these gaps disappear due to the occurrence of many isomers, etc., so that the TBP becomes more smooth and continuous. For mixtures in the intermediate boiling range such as gasoline, the TBP curve starts out as a series of plateaus and gradually changes to a smooth curve as the boiling point is increased. The TBP and ASTM distillation curves always cross, the TBP having the lowest initial boiling point and the highest end point. Although the TBP method of fractional analysis is more definite with respect to the components present than the ASTM method, the latter is universally used in preference to the TBP distillation in refinery process design and plant control work because: a) petroleum products are specified by ASTM standards; and b) the ASTM distillation is simpler and more convenient, requiring about one-tenth the time to run. However, the ASTM is inadequate for many problems and must be supplemented by the TBP distillation.

The results of these analytical distillations are given as plots of temperature vs. percentage off or a tabulation of the temperatures at 5 or 10 percent intervals between the initial and final. In graphical or tabular form, the results of these analytical distillation curves can not be used as a correlating variable so an average boiling point must be used. The most obvious and easily obtainable is the *volumetric average boiling point*, which is usually obtained by using five points on the ASTM curve, as follows:

$$VABP = \frac{t_{10\%} + t_{30\%} + t_{50\%} + t_{70\%} + t_{90\%}}{5}$$

It will be noted that the initial and final are not used. These two points are not usually very reliable. If the 90 percent point should be questionable, as it might be on heavy oils, then the 10 percent point should be omitted from the average so as to maintain the average nearly correct.

The molal average boiling point has been used by some authors in making correlations of petroleum properties. As the name implies, the molal average boiling point is an average of the temperatures at uniform mol percentages vaporized. The molal average boiling point of a hydrocarbon mixture could be obtained from the ASTM distillation plus a gravity vs. volume percent off curve.

From these gravities and the temperatures, the molecular weights may be estimated for each increment. With the densities and molecular weights, the weights and mols of each increment may be computed and a plot of temperature vs. molal percent vaporized constructed. This is too much trouble for most design problems so empirical correlations have been developed to give the molal average boiling (MABP) as a function of the volumetric average boiling point (VABP) and the slope of the ASTM distillation curve.

Smith and Watson[9] discuss the following five average boiling points of hydrocarbon mixtures: a) volumetric average, b) weight average, c) cubic average, d) true molal average, and e) mean average. When the mixture composition is known, all these average boiling points can be computed from the boiling points of the components. The volumetric, weight and molal averages are the summations of the products of the volume, weight or mol fractions and the boiling points of the individual components. The cubic average uses the volume fraction and the cube root of the individual boiling points, cubing the resulting summation. When the mixture is a petroleum fraction and defined by a laboratory distillation, such as the ASTM, the volumetric average is obtained by average temperatures at uniform intervals on the ASTM and the other averages are obtained from this volumetric average by means of empirical correlations. Smith and Watson[9] show the relationship between these five average boiling points on a graph.

The weight average boiling point is greater than the volumetric average, while the cubic, molal and mean are less, the molal average being the farthest away from the volumetric. These authors found that an intermediate average between the molal and cubic averages was the best average boiling point for correlating critical properties of hydrocarbon mixtures and petroleum fractions.

Watson and Nelson Characterization Factor

Olefinic, naphthanic, and aromatic hydrocarbons have a higher specific gravity (low API gravity) than paraffinic hydrocarbons of the same boiling point, which suggests using gravity and boiling point together to characterize petroleum fractions. Such a characterization factor was proposed by Watson and Nelson[11] as follows:

$$K = \frac{(MABP)^{1/3}}{Sp.\ Gr.} \qquad (153)$$

Where: MABP* = molal or mean average boiling point, °R.
Sp. Gr. = specific gravity 60/60.

The molal or mean average boiling point is found from the ASTM distillation by a method proposed by Watson and Nelson, who found that the MABP is lower than the VABP and that the difference increases with the slope of the ASTM distillation as shown by the following tabulation. The tabulated data give the approximate relationship between the VABP and MABP, the larger values give the true MABP, and the smaller give the mean MABP, which is claimed to be a more satisfactory correlating tool.

ASTM, 10 to 90 Percent Slope °F./Percent Off	Δt (VABP-MABP) °F.	
	True Molal Average	Mean Average
0	0	0
1	5	5
2	11	11
3	19	17
4	29	23
5	41	30
6	55	37
7	71	45
8	90	55

By means of equation (153) and the above table, it is possible to estimate the characterization factor for any stock from its ASTM distillation and gravity.

The following tabulation of values of K for pure hydrocarbons and typical stocks indicates variations in characterization factor:

n-Paraffins	12.8
Mono-Olefins	12.4
Naphthenes	11.0
Aromatics	9.75 to 10.5
Mid-Continent virgin stocks	11.9
Mid-Continent cracked stocks	10.85 to 11.25
Winkler stocks	11.2
Gulf Coastal stocks	11.2

The Watson and Nelson, (sometimes known as the UOP) characterization factor, is not all that is de-

* Molal and mean average boiling point are two different boiling points. The mean average has been most satisfactory in correlating hydrocarbon properties.

TABLE 13
Hydrocarbon Constants

HYDROCARBON	Mol. Weight	Atmos. Boiling Point °F.	Liquid Density Lb./Gal. at 60° F.	CRITICAL CONSTANTS T_c °F.	P_c psia	d_c Lb./CF	α_c CF/Lb.	CORRELATING CONSTANTS* -k_1	k_2	k_3
Hydrogen	2	—423	....	—400	188	1.93	1.191	1.435	1.37	41.4
Methane	16	—259	....	—116	673	10.1	0.243	1.410	1.410	30.25
Acetylene	26	—119	....	104	911	14.4	0.185	1.38	1.440	30.85
Ethane	30.1	—128	....	90	709	13.2	0.200	1.385	1.438	26.25
Ethylene	28.1	—155	....	50	749	13.5	0.186	1.395	1.420	25.75
Propane	44.1	— 44	4.22	206	618	14.2	0.191	1.375	1.445	21.85
Propylene	42.1	— 54	4.34	197	668	14.4	0.184	1.380	1.440	22.50
n-Butane	58.1	31	4.86	306	551	14.3	0.186	1.380	1.435	18.93
Isobutane	58.1	11	4.69	273	530	14.5	0.185	1.380	1.440	18.16
Isobutylene	56.1	20	5.00	293	580	14.1	0.177	1.400	1.415	19.00
Butene-1	56.1	21	5.00	291	580	13.9	0.176	1.410	1.410	18.90
Butene-2 (cis)	56.1	38.7	5.22	311	570	13.8	0.186	1.373	1.430	19.65
Butene-2 (trans)	56.1	33.6	5.08	311	570	13.8	0.186	1.373	1.430	19.65
n-Pentane	72.1	97	5.25	387	485	14.5	0.190	1.368	1.436	17.06
Isopentane (2-methylbutane)	72.1	82	5.20	370	482	14.6	0.186	1.370	1.449	16.67
Neo-Pentane (2, 2-dimethylpropane)	72.1	49	4.98	363	485	14.8	0.182	1.385	1.433	16.35
Amylene (Pentene-1)	70.1	86	5.38	394	595	16.0	0.157	1.399	1.418	17.26
Isopentene (2-methylbutene-3)	70.1	68	5.26	377	498	14.5	0.187	1.370	1.446	17.28
n-Hexane	86.1	156	5.53	455	434	14.6	0.194	1.355	1.469	15.60
Diisopropyl (2,3-dimethylbutane)	86.2	136	5.55	441	451	15.1	0.182	1.365	1.452	15.20
Neohexane (2,2-dimethylbutane)	86.2	122	5.44	422	441	15.4	0.184	1.360	1.467	15.03
Hexene-1	84.2	146	5.65	470	520	15.9	0.165	1.380	1.435	15.89
n-Heptane	100.2	209	5.73	513	397	14.6	0.193	1.360	1.460	14.19
Isoheptane (2,3-dimethylpentane)	100.2	194	5.814	509	429	15.0	0.175	1.383	1.433	13.90
Triptane (2,2,3-trimethylbutane)	100.2	178	5.78	497	437	16.7	0.174	1.350	1.472	14.10
n-Octane	114.2	258	5.88	565	370	14.5	0.191	1.362	1.458	13.10
Diisobutyl (2,5-dimethylhexane)	114.2	229	5.814	531	354	14.8	0.194	1.352	1.463	12.61
Iso-octane (2,2,4-trimethylpentane)	114.2	211	5.791	520	373	15.5	0.182	1.353	1.465	12.58
Octene-1	112.1	250	6.00	581	452	16.1	0.162	1.380	1.462	13.55
Cyclohexane (Hexamethylene)	84.2	177	6.52	538	594	17.0	0.1550	1.380	1.436	17.04
Benzene	78.2	176	7.37	551	700	19.0	0.1455	1.356	1.460	18.92
Toluene (Methylbenzene)	92.2	231	7.26	609	611	18.2	0.1486	1.370	1.448	16.80

*k_1 are dimensionless ratios. k_2 units are Gram—Cal(/GM-Mol) (°C) or Btu(/Lb.-Mol.) (°F.). k_3 units are Btu/Lb.

sired but it is the most useful available for process design purposes. For heavy oils where the ASTM distillation cannot be obtained the U.O.P. characterization factor is obtained from a viscosity-gravity correlation. For such oils another characterization factor has been proposed.

Other Characterization Factors

Although they are not as useful in hydrocarbon process design as the Watson and Nelson characterization factor, there are other characterizing factors using viscosity and aniline point data.

Viscosity-Gravity Constants. Viscosity is an indication of the characterization or composition of hydrocarbon mixtures. Paraffinic stocks have a higher viscosity than aromatic stocks of the same gravity. Likewise for oils that have the same viscosity, those oils which are paraffinic have lower specific gravities than those that are naphthenic. A correlation of viscosity and specific gravity, therefore, gives a numerical index of paraffinicity. Hill and Coates[7] proposed such an index which is called viscosity-gravity constant (VGC) and is defined by the following equation:

$$VGC = \frac{10\,S - 1.0752 \log (SUS - 38)}{10 - \log (SUS - 38)} \qquad (154)$$

Where S = specific gravity 60/60
SUS = viscosity in Saybolt Universal Seconds at 100° F.

VGC is low for paraffinic crudes and high for naphthenic crudes as indicated below:

Pennsylvania	0.75
Mid-Continent	0.83
Gulf Coast	1.00

Paraffinic stocks have high viscosities as compared to aromatic fractions of the same gravity. The viscosity-gravity constant of Hill and Coates[7] is applicable only in the lubricating oil range. Watson, Nelson and Murphy[12] found that the UOP characterization factor could be correlated as a function of viscosity and gravity. The correlations presented cover the gasoline to heavy residue range, thus overlapping with the gravity-boiling point correlation.

Diesel Index. The aniline point, which is the temperature of complete miscibility of equal parts of oil and aniline, or the critical solution temperature, is a way of measuring the paraffinicity of petroleum fractions. Paraffinic oils have higher aniline-points than unsaturates or aromatics of the same average boiling point. Aniline point characterization methods are limited to clear oils because the determinations are difficult on heavy dark oils.

Watson, Nelson and Murphy[12] also presented a correlation for obtaining the UOP characterization factor from aniline point and average boiling point.

Aniline point is used with gravity to give the so-called "Diesel Index," which is used to compare the paraffinicity and the compression-ignition characteristics of oil. The equation for the Diesel Index is:

$$\text{Diesel Index} = \frac{(°API)\ (\text{Aniline Point } °F.)}{100} \qquad (155)$$

The values of this index vary from 50 to 60 for paraffinic fractions to 30 for naphthenic fractions. Thus, gravity, boiling point, viscosity and aniline point are related through the UOP characterization factor. This relationship should not be abused, however. It is not intended that average boiling point be obtained from viscosity via the characterization factor correlation.

Hydrocarbon Constants

In applying the thermodynamic functions to hydrocarbons by the generalized procedure mentioned above, it is necessary to have the critical constants for the individual components. These constants have been assembled and are presented in Table 13 for 32

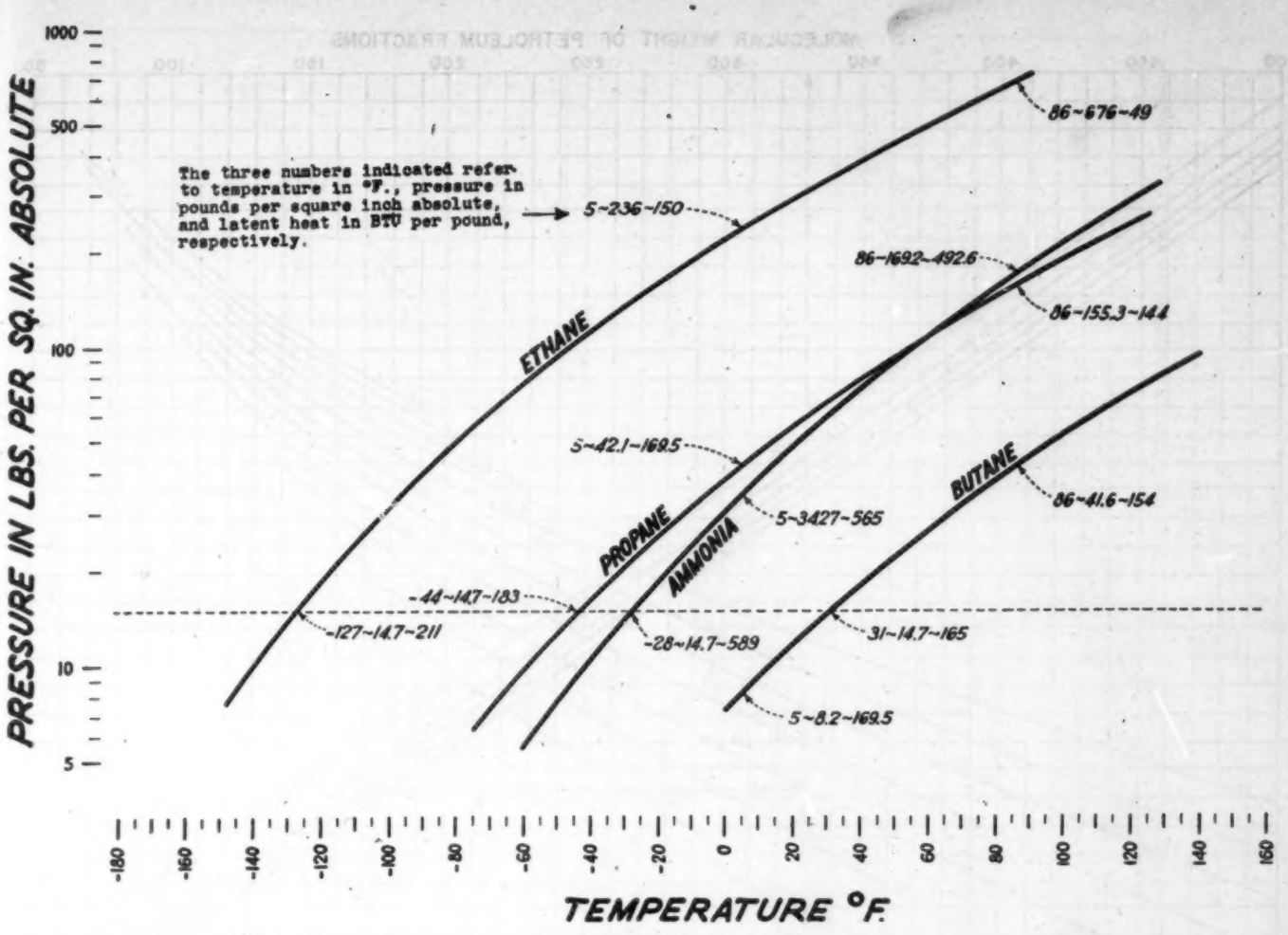


FIGURE 13

Typical vapor pressure curve with latent heats indicated for hydrocarbons in normal refrigeration range, including ammonia.
—Courtesy Standard Oil Company (Indiana)

hydrocarbons of various molecular structures boiling between hydrogen and normal octane.

Included in this table are the molecular weights, atmospheric boiling point, liquid density at 60°, the critical data and the correlating constants, the latter being computed from the critical constants in a method to be described later. The sources of these constants are Hanna and Matteson[6], API Research Project 44[1], plus miscellaneous data in the author's files. Hanna and Matteson give a rather complete bibliography on physical constants and include several other constants such as heats of combustion, etc. For the immediate needs of this series, the data given in Table 13 are sufficient. Later when other hydrocarbon constants are required, they will be included.

The constants given in Table 13 are for pure hydrocarbons. In order to use these data for mixtures, the composition of the mixture must be known. Occasionally the thermodynamic calculations are concerned with "hypothetical" rather than "actual" components of a mixture. A "hypothetical" component is a narrow boiling mixture which will usually contain paraffins, olefins, etc. The constants for these hypothetical components are found for the narrow mixture as functions of gravity, boiling point, etc. Correlations for these critical data are based on experimental data and will be presented later.

In discussing hydrocarbon properties, it is of interest to distinguish between *basic measured* properties on the one hand and *derived* properties on the other hand. Some of the thermodynamic properties with which these articles are concerned can be evaluated only by experimental measurements. Others must be derived by applying thermodynamic equations to the fundamental data. Some properties may be found either by measurement or derivation. This is fortunate because it gives a means of checking the thermodynamic methods.

The measured data required in preparing entropy and enthalpy charts are: a) vapor pressures, b) saturated liquid and vapor densities, c) PVT data for superheated vapors, d) heat capacities at one pressure.

From these data the following properties can be derived: a) heat capacities at other pressures, b) difference in specific heats at constant pressure and volume, c) Joule-Thomson coefficient, d) entropy and enthalpy of vaporization, e) isobaric effect of temperature on the enthalpy and entropy, f) isothermal effect of pressure on entropy and enthalpy, g) the ideal solution of fugacities, h) the effect of temperature and pressure on the free energies.

Those of the above derived properties that can be measured and thereby check the computations are: a) the heat capacities at other pressures, b) the Joule-Thompson coefficient, c) the isothermal effect of pressure on the enthalpy, etc. The Joule-Thomson coefficient, which is the rate of temperature change with pressure change at constant enthalpy, is easily determined because it is not necessary to measure

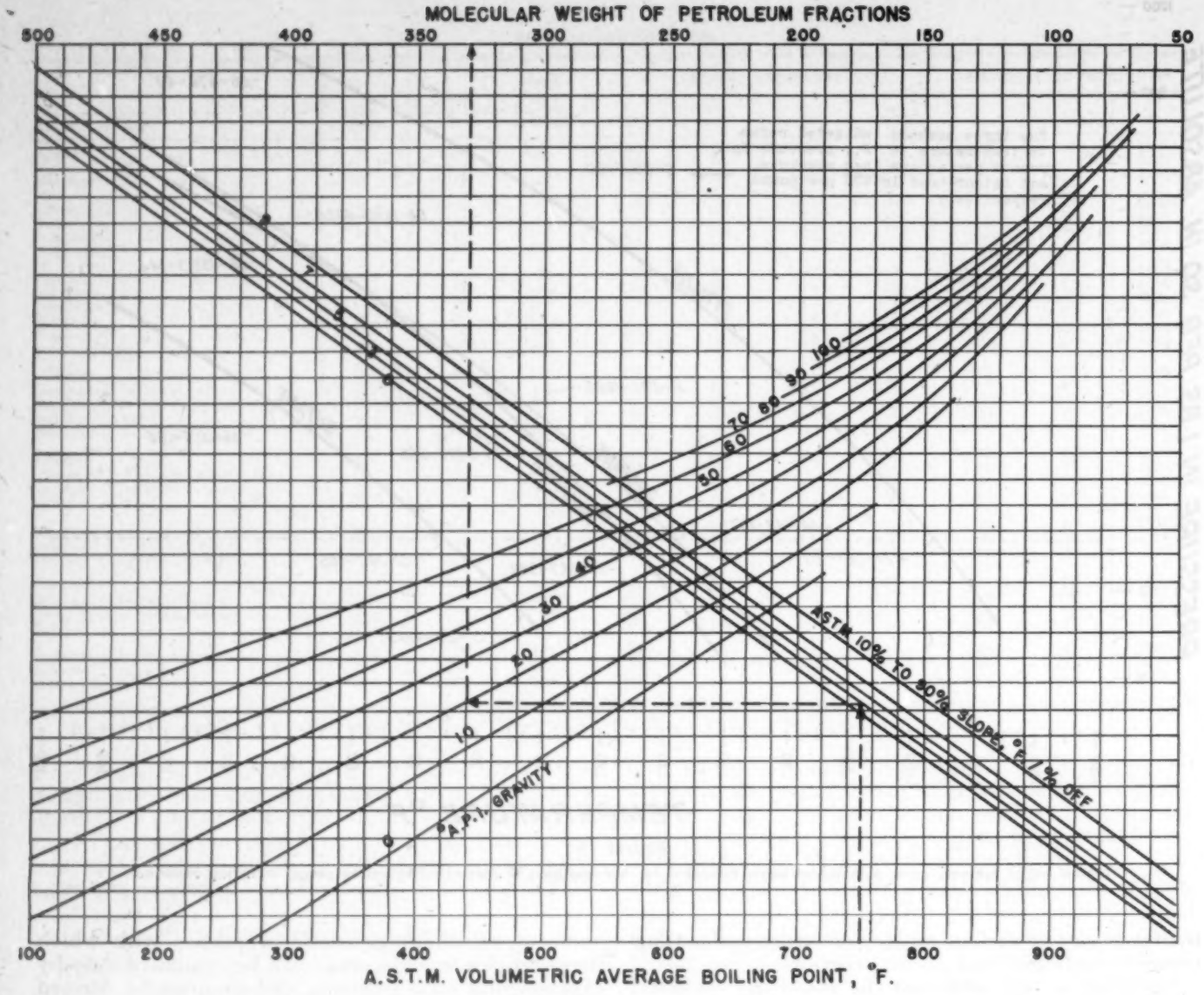


FIGURE 14

Molecular weights of petroleum fractions as function of gravity and ASTM distillation properties.

heat quantities. The isothermal effect of pressure on the enthalpy, which is equal to the product of the Joule-Thomson coefficient and the specific heat and of opposite sign, is more difficult to determine experimentally. A throttling calorimeter is used for this determination.

In developing the steam tables and Mollier diagram for steam, many of the derivable thermodynamic properties were also measured in order to check the results.

The above pertains to the physical and thermal behavior of a single fluid, either a pure component or a mixture that may be treated as a pure component. The thermodynamics of solutions, phase equilibria and reactions are more complex. In addition to the above measured properties, experimental data on the phase behavior of non-ideal solutions are required for developing activity coefficients to get actual fugacities from ideal fugacities, the latter being obtained from PVT data. Data on heats of mixing are required in making heat charts from non-ideal mixtures. Also, experimental data on the heats of combustion and heats of fusion are required for computing the free energies of formation for use in developing reaction equilibrium constants.

It is of interest to point out that enthalpy and entropy charts can be prepared for individual hydrocarbons so as to include the entropies and enthalpies of formation. With charts such as these, it is possible to compute the heats of reaction between any two or more hydrocarbons. For this purpose similar charts would be required for carbon and hydrogen.

With reference to hydrocarbon reaction equilibria, the recent compilation prepared by the National Bureau of Standards, as Research Project 44, for the American Petroleum Institute gives the most complete and reliable values of heat capacities, entropies, enthalpies, etc. for the hydrocarbons. This API Research Project 44 work was directed by Rossini who has been the co-author of many papers reporting these results. The completed tabulations are given in collection of mimeographed papers[1]. Other significant work on hydrocarbons has been done by Cragoe[3,4] who compiled and correlated liquid densities and volume pressure fractions for the four carbon atom hydrocarbons. This latter work was done in connection with the synthetic rubber and aviation gasoline programs to provide accurate data for computing the volumes of charge stocks.

Figure 13 shows typical vapor pressure curves of

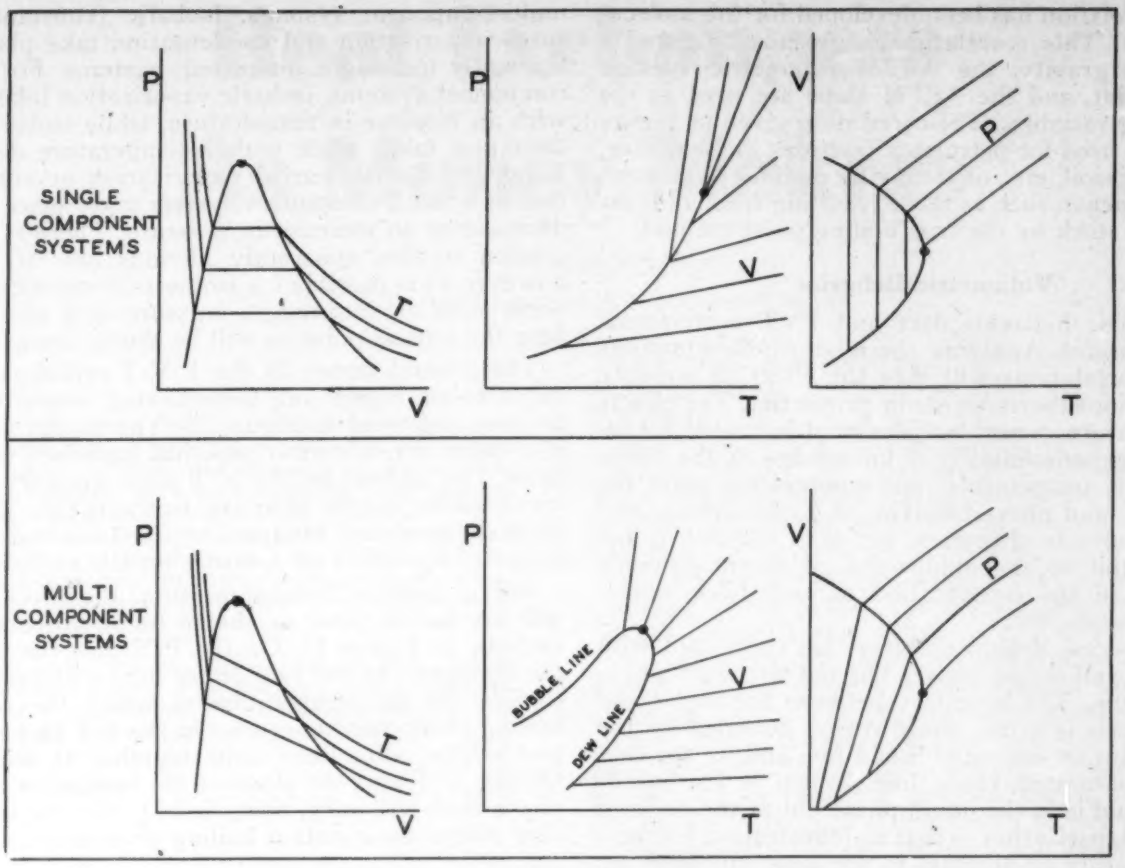


FIGURE 15

PVT plots for single and multi-component systems, illustrating three different methods of plotting.

three hydrocarbons plus ammonia with the latent heat of vaporization indicated at a few typical points. Data such as given on Figure 13 are important in making refrigeration cycle calculations. These data are typical of the kinds of data needed.

Molecular Weight and Structure

The molecular weights of the pure hydrocarbons are known precisely and for those of particular interest in this paper the values are given in Table 13. For petroleum fractions, on the other hand, the molecular weights must be predicted from empirical correlations based upon experimentally determined values such as those given by FitzSimons and Thiele.[5]

A true boiling point distillation with gravity determinations for the various cuts will, in practically all cases, give sufficient information about the stock at hand for design purposes. With gravities and boiling points of narrow cuts, it is possible to estimate the molecular weight of hypothetical components from Table 13 or from a plot of molecular weight vs. boiling point and gravity. For this estimation, a graphical correlation is most convenient. For most work the ASTM distillation and gravity of entire stock must be sufficient so correlations are based on this information.

It is often desired to determine experimentally the amounts of olefins, aromatics, naphthenes, and paraffins in the entire sample or in the different boiling ranges. The quantity of olefins present can be found by determining the bromine number, which is the number of grams of bromine absorbed (at the double bond) by 100 grams of the oil. Olefins and aromatics can be removed by absorption in 98 percent sulfuric acid and P_2O_5, thus giving the sum of olefins and aromatics. The residue from this test, which is known as the Kattwinkle, consists of paraffins and naphthenes. At the same boiling point, a naphthene has a higher refractive index than a paraffin hydrocarbon. The relative amounts of paraffins and naphthenes in the residue from the Kattwinkle can be estimated by finding the refractive index of the residue. Below the boiling point of benzene sulfuric acid absorption will give the amounts of olefins present because there are no aromatics to be absorbed.

In process design work, it is usually necessary to estimate the molecular weight of hydrocarbon mixtures and petroleum fractions from simple inspections such as the gravity and the ASTM distillation. The molecular weight for a light hydrocarbon mixture can be computed from a fractional distillation analysis if this is available. However, the direct determination of the molecular weight of hydrocarbon gases by the vapor density method is simpler than running a fractional distillation. Besides the vapor density method for determining molecular weights, there are the freezing point and the boiling point methods. In the freezing point method, the molecular weight is determined by observing the effect of a small amount of the oil on the freezing point of a given solvent such as benzene, nitrobenzene, cyclohexane, etc. In the boiling point method, the molecular weight is determined by observing the effect of a small amount of the oil on the boiling point of a solvent, such as benzene, heptane, iso-octane, carbon tetrachloride, etc.

Empirical correlations giving the molecular weight of petroleum fractions have been presented in the literature.[12] Using these data and correlations, a more

direct correlation has been developed for the molecular weight. This correlation is given as Figure 14 where the gravity, the ASTM volumetric average boiling point, and the ASTM slope are used as the correlating variables. The correlation given in Figure 14 may be used for petroleum fractions like gasoline, kerosine, gasoil, etc., or it may be used for hypothetical components, such as those resulting from a breakdown of a stock by the true boiling point method.

Volumetric Behavior

Volumetric behavior data and PVT correlations are very useful. Applying thermodynamic equations to such correlations will give the effect of pressure on the various thermodynamic properties. The effects of temperature cannot be calculated but must be determined experimentally. A knowledge of the effect of pressure, temperature, and composition upon the volumetric and phase behavior of hydrocarbons and their mixtures is of interest per se in addition to being essential to the application of thermodynamic equations in the computation of enthalpies, entropies, fugacities, etc.

Most process design problems are concerned with the vapor and liquid phases but not the solid phase of petroleum. The boundary between the vapor and liquid phases is a two phase region bounded by the bubble point or saturated liquid line and by the dew point or saturated vapor line. When at its bubble point, a fluid is in the liquid phase but at the point of incipient vaporization so that an infinitesimal increase in temperature or decrease in pressure will start vaporization. When at its dew point, a fluid is in the vapor phase but at the point of incipient liquefaction so that an infinitesimal decrease in temperature or increase in pressure will start liquefaction. In this two phase region the vapor and liquid phases are each saturated, i.e., at or between their dew and bubble points, respectively, and in equilibrium with each other. The bubble point line is the 0 percent vaporized line whereas the dew point line is the 100 percent vaporized line. For a pure compound (single-component system) the bubble and dew points occur at the same temperatures for any given pressure, although the volumes are different.

For a multi-component system, the bubble point temperature is lower than the dew point temperature at the same pressure. The wider boiling the mixture, the greater this difference in bubble and dew points. When plotted on pressure-temperature coordinates the bubble and dew points for a pure component fall on the same curve, the vapor pressure curve, which ends at a point called the critical point. When the bubble and dew points for multi-component systems are plotted on the same scales, two curves result. These two boundary curves, which are called the bubble point and dew point lines, meet at the critical point defining what is called the border curve.

The P-T plots for single and multi-component systems are shown in Figure 15. In addition to the P-T plots, P-V and V-T plots are given in Figure 15 for single and multi-component systems. These plots show other important differences between single and multi-component systems. Isobaric (constant pressure) vaporization and condensation take place isothermally for single component systems. For multi-component systems, isobaric vaporization takes place with an increase in temperature, while isobaric condensation takes place with a temperature decrease. Likewise, the isothermal vaporization or condensation of a multi-component system takes place with a decrease or an increase in pressure. There is an exception to this apparently obvious law of nature, however. It is possible for isothermal vaporization to occur with an increase in pressure in a given zone near the critical point as will be shown later.

The general trends in the P-V-T relations in the supercooled liquid and superheated vapor regions are also indicated in Figure 15. The isochors on the P-T plots are, for most practical purposes, straight lines. The isobars on the V-T plots are curved to a much lesser degree than the isotherms on the P-V plots. Data of this kind are required for the computation of the effect of pressure on the enthalpy, etc.

For a constant boiling mixture, the P-V-T plots will not be the same as shown for multi-component systems in Figure 15. On the P-V plot the slope of the isotherms in the two phase field will vary down to zero for the temperature at which the constant boiling phenomenon occurs. On the P-T plot the dew and bubble point lines come together at this point. On the V-T plot the slope of the isobars in the two phase zone will vary, being infinity for the temperature where the constant boiling phenomenon occurs.

Conclusions

This installment starts the treatment of the thermodynamic properties of hydrocarbon fluids. This is a large and interesting subject because of the complexity of the working fluids and also because of the way a small amount of data may be made to go a long way by the proper application of thermodynamics. In the next installment, the P-V-T correlations will be presented and discussed.

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End of Part VII; Part VIII will appear in the next issue.

Heat Exchangers As Money Makers

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AS THE author words it, "... the main idea in putting in heat exchangers is to make a profit." Many technical writings have treated the thermal and mechanical design of heat exchange equipment, and a few have considered the economic factors involved, usually in mathematical terms.

In this plain language treatment of an important and complex subject, the author dispenses with formulae and discusses in simple terms the procedures and bases by which heat recovery equipment is selected. Design factors are considered, and charts are used to illustrate the effect of changes in major variables.

In its original form this work was presented as a program topic before a meeting of the Southern California Section of the ASME, under the title, "The Economics of Heat Recovery Exchangers," and has not been scheduled for publication elsewhere.

THE term "heat exchanger" has two meanings. One is general. It covers all types of equipment such as condensers, reboilers, coolers, and the like. The other is specific, and refers to recovery of heat otherwise wasted. Exchangers of this latter type will be discussed here.

Such exchangers might well be called heat recovery exchangers. For heat recovery is their purpose. Thus they are money savers, if applied properly. They are not absolutely essential. In fact, at the beginning of the petroleum industry, they were not used.

The expression "payout" in general means the length of time needed to pay back the original cost. There are several ways of computing payout, but the simplest way is to divide the original cost by the gross savings per year. No allowance is made for various expenses. When such a simple method is used, the payout time is kept short, say not over two years.

Another method is to allow for all expenses—maintenance, replacement of elements, and taxes. When using this method, a longer time is allowed, say up to five years. Interest can be included if desired. But as a rule, once the investment is paid back, the profit is so large it outshadows any 5 percent interest charge.

Using payout an engineer can be fairly sure of getting his money back with some profit. He always starts out with some set payout period suited to his method of computing his economics. He shades this up or down, in accordance with his judgment. If he thinks that the process involved may become obsolete at an early date, he takes shorter payout time.

Profit the Main Idea

The foregoing method is a check against loss in capital. But it does not recognize that the main idea of putting in exchangers is to make a profit. And just because a project pays for itself in a certain time, is by no means proof that it is the most profitable.

There is another interesting and useful point not brought out by the payout method. Suppose the plant continues beyond the payout period. Five years is about as great a period as oil refinery engineers use. But the majority of plants operate for 15 years. Then we should at least take a look at the profits returned in ten years. The answer could easily influence our selection.

In analyzing the basic economics involved, we have 1) capital charges 2) expenses 3) savings and 4) profit. Capital charges are the original costs, and include the exchanger, foundations, piping, insulation, supports, labor, and painting. "Expenses" include labor for repairing and cleaning, as well as replacement parts, such as new tubes, or new elements.

Savings refer to cost of fuel and cooling water

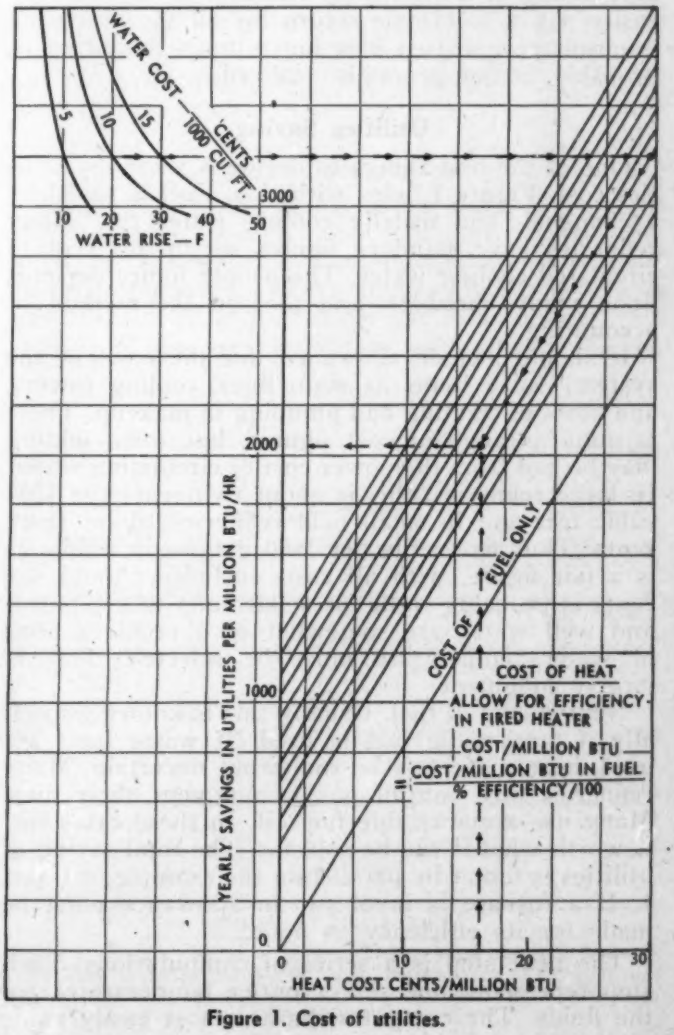


Figure 1. Cost of utilities.

Which are not required because of heat returned back to use. Profit is more or less what is left. Profit does not begin right away. The exchanger can be pictured as steadily putting money into the bank due to savings in utilities.

Part of this fund must be set aside to take care of expenses when they occur. For these expenses occur at widely spaced intervals. What is left, must, for a while, be put into what might be called a returned investment fund. Eventually this fund is equal to the original cost. Then and only then, is part of the incoming money turned into profit.

Accountants have a little more complicated way of taking care of the operation. They also have quite different names for the various steps. Many times the steps appear in such widely separated places in the books that one cannot easily see the connection. Therefore, it is always advisable to build up some simple picture for oneself.

	HOT - °F		COLD - °F		APPROACH - °F		LOG MTD	HEAT BTU/HR	SURFACE SQ FT	MAINT $/FT²/YR	COST @6$/FT²
	IN	OUT	OUT	IN	COLD	HOT					
1	450	150	300	100	50	150	91	20 MILLION	2930	3510	17,580
2	450	125	317	100	25	133	64	21.67	4500	5400	27,000
3	450	175	283	100	75	167	114	18.33	2140	2570	12,840
4	450	200	267	100	100	183	137.5	16.67	1615	1940	9690
5	450	115	323	100	15	127	52.5	22.3	5660	6800	33,960
6	450	105	330	100	5	120	36.2	23.0	8480	10,150	50,880

	SAVINGS/YEAR		PAYOUT	5 YEAR		10 YEAR		PROFIT AVERAGE YEARLY %	
	GROSS	NET	YEARS	GROSS	NET	GROSS	NET	5 YEAR	10 YEAR
1	30,000	26,500	0.66	132,500	114,900	265,000	247,400	130	140
2	32,500	27,100	1.00	135,500	108,500	271,000	244,000	80	90
3	27,500	24,930	0.51	124,650	111,800	249,000	236,000	174	184
4	25,000	23,060	0.42	115,300	105,600	230,600	220,000	218	228
5	33,450	26,650	1.27	133,250	99,300	266,500	232,500	58	68
6	34,500	24,350	2.09	121,750	70,900	243,500	192,000	28	38

ASSUMED HEAT TRANSFER RATE 75
COST OF UTILITIES $1500/YR/MILLION/HR

Figure 2. Computations for Figure 3.

One peculiar condition is worthy of note. At the beginning there is no profit. The savings must all be turned over as fast as they are made. But once the exchangers are paid for, the profits roll up. They accumulate at a high rate. The first profit year can easily pay a handsome return for all the preceding no-profit period. Just how big a profit this often is, probably is not generally realized.

Utilities Saving

One of the first things to decide is what the utilities cost. Figure 1 helps with this. Fuel is saved by exchangers, and usually cooling water too. Many refineries have standard figures set up for cost of circulated cooling water. The proper figure depends upon many variables, and too, on the method of accounting.

It should include allowances for the costs of the system,—such items as main lines, cooling towers, and costs of treating and pumping in makeup. There is quite a range of cost figures, but some inkling may be had from the power cost of circulating water. In large refineries, this is about two cents per 1000 cubic feet and in small field refineries, about three cents. Thus five cents per 1000 gallons in refineries is a fair figure, with all costs included. About ten cents is probably right for small units where power and well water are somewhat of a problem. Rise in water temperature must be selected. This is largely judgment.

Next is cost of fuel. Usually this is known, especially if marketable fuel is used. If waste fuels are used, heat costs may be somewhat uncertain. Many refineries buy natural gas to augment their own. Many use a marketable fuel oil. In these cases fuel is worth what it can be sold for. The total saving of utilities is found by paralleling the example of Chart 1. If a furnace is involved, an allowance must be made for its efficiency as noted.

The next step is a series of computations. Each step represents one set of outlet temperatures for the fluids. The computations are most easily made

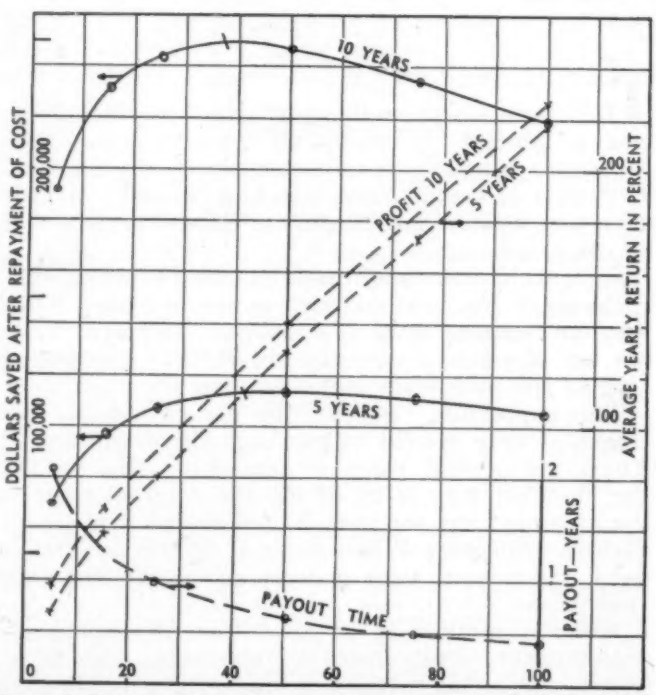


Figure 3. Showing effect of time and temperature approach. (Installed cost, $6.00/sq. ft.; Maintenance and repair, $1.20/sq. ft. yr.; Heat transfer rate 75; Heat $1500/Yr./Million/Hr.; Hot fluid 450° F.; Cold fluid 100° F.; Average heat 20,000,000 Btu hr.)

in tabular form. Various values must be assumed—largely by experience. Cost of exchangers per square foot, heat-transfer coefficients for example. These vary so widely that it is impossible to make simple charts. The variables in costs are pressure, tube-size, tube-layout, materials, size of individual exchangers. Besides that, costs have been rising steadily. The cost range per square foot, is some eight-fold, due to these variables.

The best way to illustrate a principle is to work out some simple problem as follows:

Hot oil available at 450° F.
Cold oil available at 100° F.

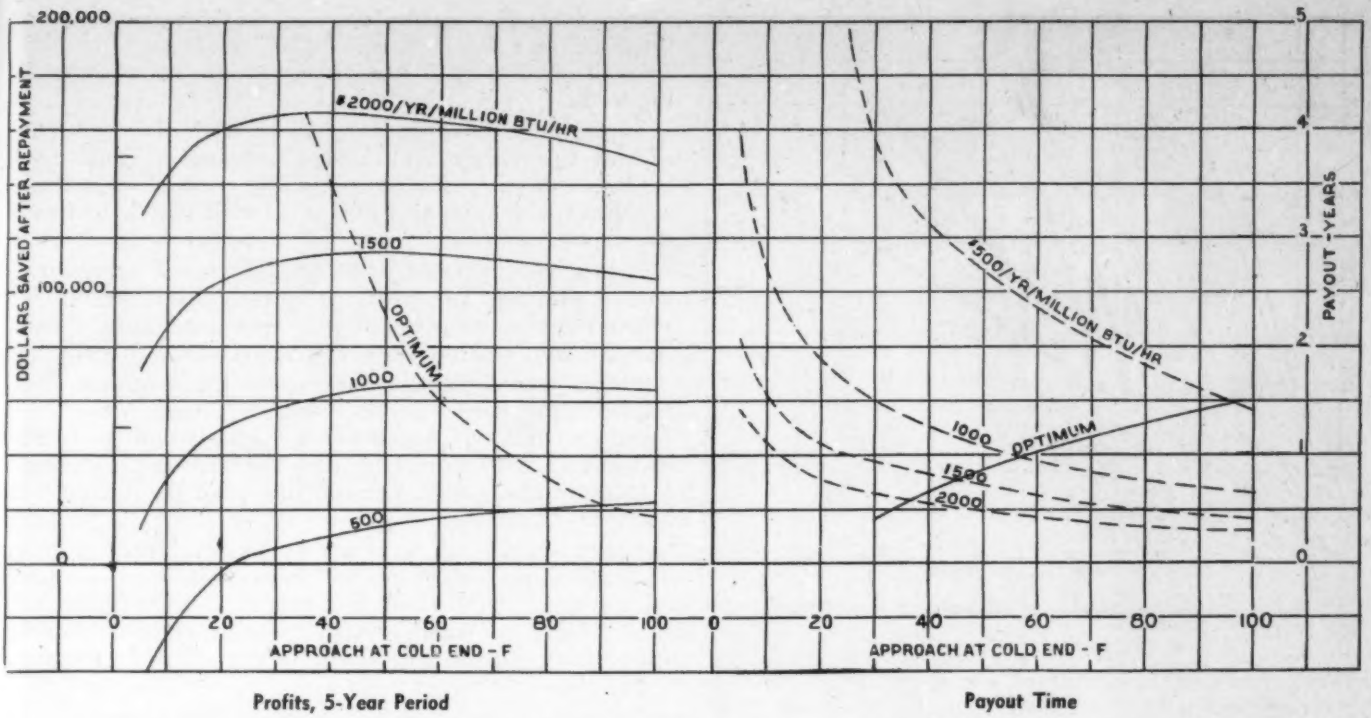


Figure 4. Effect of utilities cost. Installed cost, $6.00 per square foot; maintenance, $1.20 per square foot; heat transfer rate, 75; hot fluid, 450° F.; cold fluid 100° F. Average heat, 20 million Btu per hour.

Heat—when cooling the hot fluid to 150° F. and heating the cold fluid at the same time to 300° F., 20,000,000 Btu/hr.

Overall heat-transfer rate, 75 Btu per hour per ° F. per square foot.

Exchanger cost installed, $6.00 per square foot.

This should allow from $1.50 to $2.00 per square foot for complete installation.

Maintenance per year—Say 20 percent of installed cost. (This should allow for a new element every three years, and for cleaning twice a year).

Heat—Worth $1500 per year per million Btu per hour.

Figure 2 gives computations. 1) Take different temperature approaches. 2) Compute mean temperature difference. 3) Find heat recovered. 4) Compute surface, its cost, and its maintenance. Next to find gross savings, multiply heat by $1,500. Next subtract the yearly maintenance. This gives the yearly return.

This return is first turned to repayment of capital. Payout time is determined as a matter of interest. Next find out what happens in five years. The net money is coming in through this period. Then take out the investment. The rest is profit. The same is done for ten years.

Plot of Computations

Results are plotted on Chart 3. Basis is temperature approach, though other variables can be used. Note that the profit reaches a maximum at about 40° to 45° F. approach. The ten-year and five-year periods have maximum at practically the same point.

Here is one very important point: Once you go

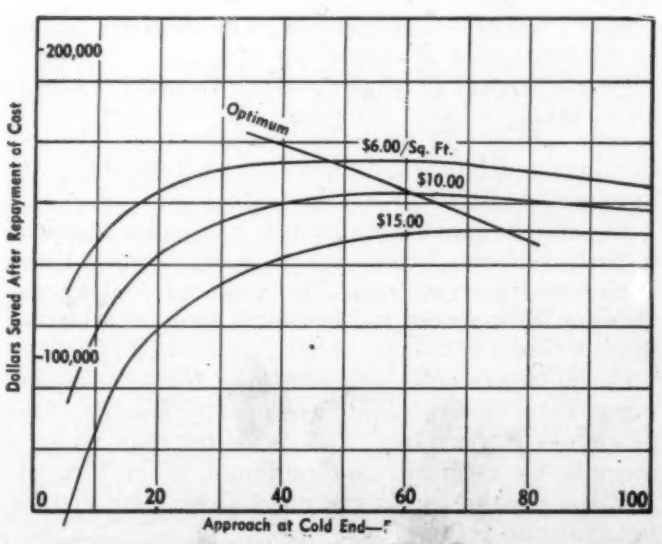


Figure 5. Showing effect of cost of exchange, 5-year period. (Maintenance, $1.20/sq. ft./yr.; heat transfer rate, 75; heat $1500/Yr./Million Btu/hr.; hot fluid 450° F.; cold fluid 100° F.; average heat 20,000,000 Btu/hr.)

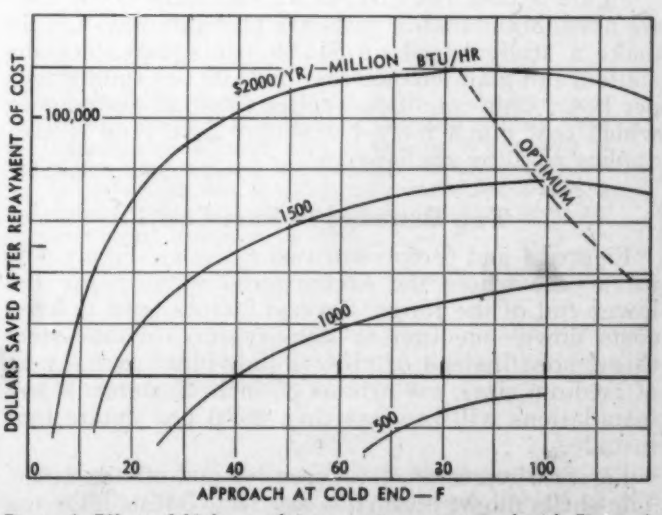


Figure 6. Effect of higher exchanger costs as compared with Figure 4. (Five years—installed cost, $15.00/sq. ft.; maintenance, $3.00/sq. ft./yr.; heat transfer rate, 75; hot fluid 450° F.; cold fluid 100° F.; average heat 20,000,000 Btu/hr.)

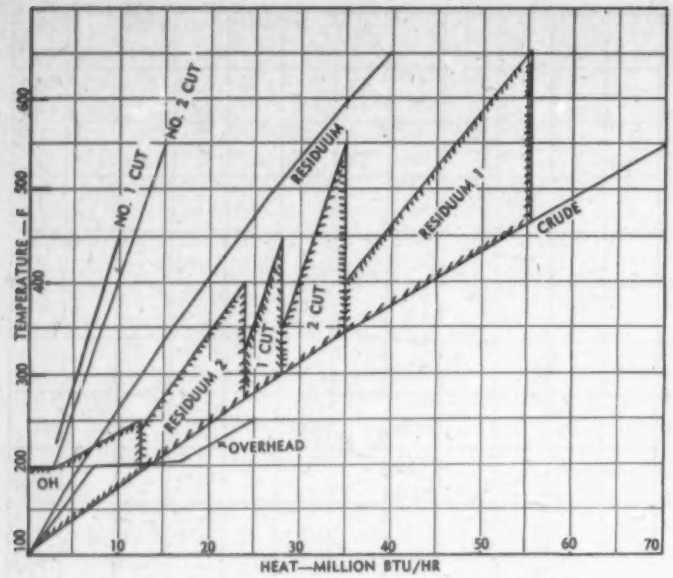


Figure 7. Heat picture showing arrangement of exchangers.

very far below the optimum, the profit drops rapidly. Payout time is plotted. Note that the optimum point is close to the break-point of the payout curve.

In case some one wishes to know what interest rate is returned, it is plotted too. At the optimum-point it is about 100 percent per year, for this case. And this is after return of capital.

Figure 4 shows the effect of utility cost, when other values are kept the same as for Figure 3. The left-hand chart gives net return. The right-hand chart gives payout time. Note that the optimum temperature approach does not change greatly as $2000 per year million Btu per hour drops down to $1000. But a big change occurs in going to $500. Luckily such a low utility cost is rare. Still the payout for $500 is surprisingly fast.

Figure 5 shows effect of exchanger cost. Other values remain as for Figure 3. Even the maintenance charge of $1.20 per square foot per hour is the same. For the values assumed, at least, exchanger costs can vary considerably without much effect. The optimum point changes. But the $15 curve is so flat that the same temperature approaches could be taken.

Figure 5 does not give us all the comparisons that we need. Maintenance costs are probably low. Let us make a study based on $15.00 per square foot installed, and maintenance cost of $3.00 per square foot per hour. This condition applies to small exchangers which cost much more per square foot. And it also applies to alloy exchangers.

Two Extremes in First Cost

Figures 4 and 6 represent two extremes. Figure 4 is for a case where the exchangers-cost are near the lower end of the range. Several factors tend to keep costs down—medium or low-pressure—carbon-steel throughout instead of alloys—individual exchangers of medium sizes, say around 30-inch diameter. Many installations will run less than $6.00 per square foot installed.

Figure 6 represents the expensive and off the range. The shells might be small—say 12 to 15-inch. Or the metal may be an expensive alloy. Or pressure might be high, or heat-transfer rate low.

Heat-transfer has the same influence as cost per square foot. For example, a rate of 75 was used for these charts. But if a rate of 27 were used for the example of Figure 4, the curves would coincide with Figure 6.

Sometimes an engineer is faced with the problem of how to arrange a number of streams of fluids for best results—for example, a simple crude unit having overhead, sidecuts, and bottoms, with which to heat the crude.

A heat picture is of great help. Figure 7 represents such a picture. The heat contents of each stream is plotted against temperature. It is well to draw these lines in ink, so that they will show through vellum.

Lay a sheet of graph paper over the original. The heat-content lines can be traced by hand, since extreme accuracy is not needed. Each stream is filled in by trial and error. The lines are shifted by sliding a triangle on a ruler. Curved lines can be shifted by sections.

Other setups can be made by placing fresh sheets of graph paper on the original. One solution is shown on Figure 7. Note that the residium exchangers are in two separate banks, with the side streams interposed between. This is an application of an important principle.

Thermodynamics books have a high-toned name for it. We might call it "maintenance of temperature level." Or "segregation of temperatures." To drive heat from a hot fluid into a cold fluid, there must be a temperature difference. If the residuum is cooled too much in one bank, this driving force is lost. So, simply continue the cooling in another bank where the crude is at a lower temperature. The side cuts are put in between, where their temperature ranges naturally belong.

Such heat pictures are used by a number of engineers. Still their use is not universal. Flow arrangements are often specified, indicating quite clearly that a heat picture has not been used. Sometimes several different crudes must be run. In such cases, heat pictures really pay off. Considerable skill and patience are needed to obtain an arrangement that is flexible. With a picture in front of you, you can greatly simplify a complicated problem.

Summary

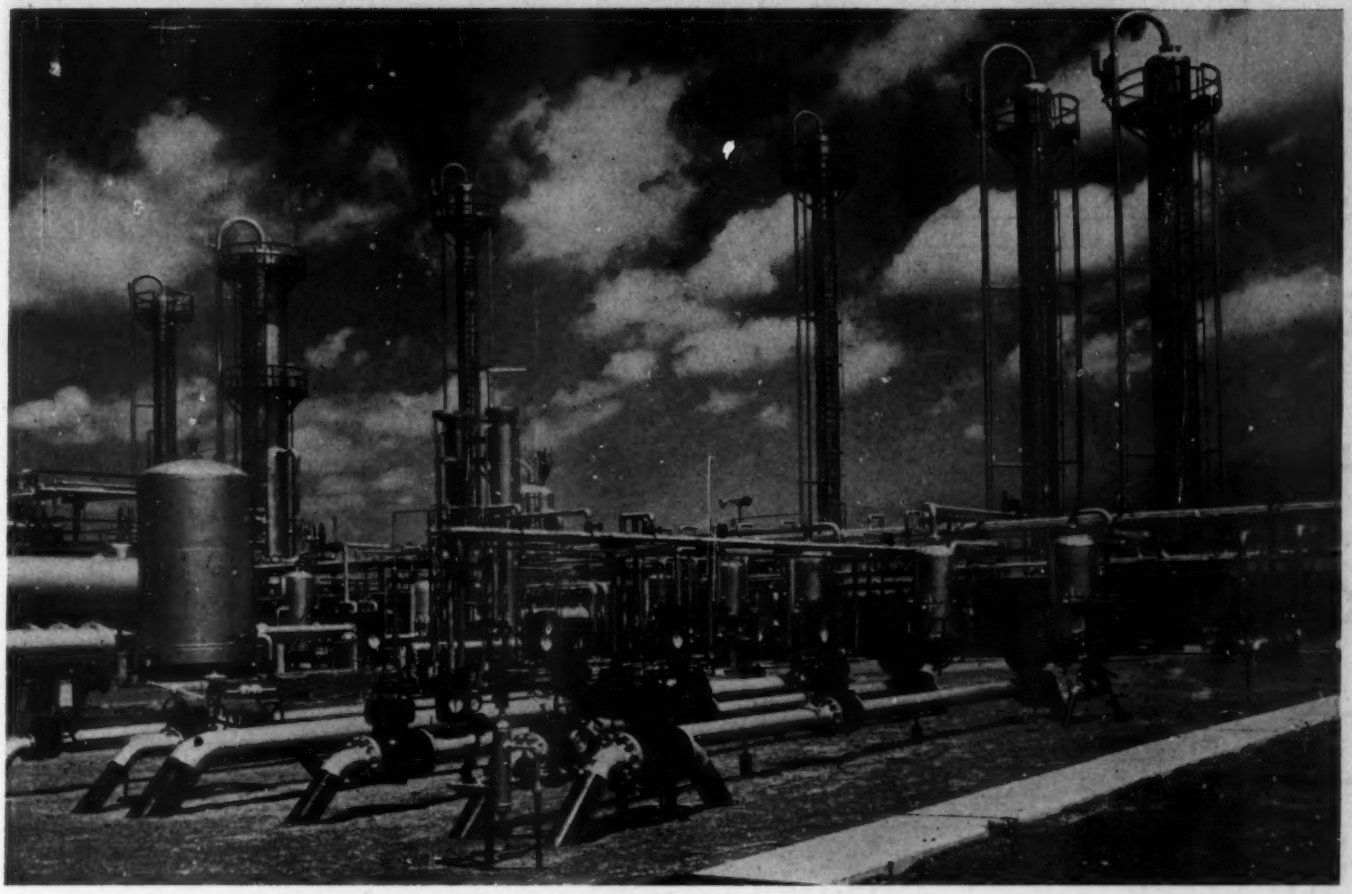
Heat Recovery—The foregoing discussion has applied to the economics of recovering heat.

Proper Method of Analysis—Heat recovery is a matter of saving money. Therefore, the best installation is that which will make the most money. The exchangers must pay for themselves before the plant becomes obsolete.

Payout—In general, the payout is so quick that it is of little concern. Profits are in general many times the normal interest rate. The economics of an exchanger bank should not be based upon an arbitrary payout time.

Computations—Use a tabular form for the computations. Four or five points are usually enough. This procedure is very fast. This is better than using a formula to ascertain the optimum point directly. Because plotting the curve gives a complete picture, not just one point.

Heat Picture—These are handy where several streams are involved. Several trials can be made by laying sheets of transparent graph paper on an original.



View of Humble Oil & Refining Co.'s Clear Lake Gasoline Plant Processing Area Showing Gas Pipe Line Meter Runs and Control Valves in the Foreground.

Clear Lake Plant Designed for Propane-Gasoline Product

C. C. PRYOR, Associate Editor

THE new $2,250,000 gasoline plant recently placed in operation by Humble Oil & Refining Company at Clear Lake, approximately 20 miles south of Houston, is processing 50 million cubic feet daily of natural gas—19 million cubic feet of gas well gas, and 31 million cubic feet of casinghead gas formerly flared as waste. The article describes process and construction features of the plant.

HUMBLE Oil & Refining Company's new gasoline plant at Clear Lake is currently producing 36,000 gallons daily of a single product—deethanized gasoline of about 95 RVP, composed of about 32 percent propane, 38 percent butane, and 30 percent pentanes plus, which is delivered by pipe line to the company's Baytown refinery.

The plant is designed to recover 55 percent of the propane, 90 percent of the butanes, and 100 percent of the pentanes and heavier from the 50 million cubic feet of gas processed daily, consisting of 31 million cubic feet daily of casinghead gas and 19 million cubic feet of gas well gas. Residue gas from the plant is delivered to the transmission system serving the Baytown refinery.

Built at a cost of $2,250,000 the plant was initiated as one project in a $10 million program by Humble to conserve and utilize casinghead gas formerly flared from oil wells. Gas from the fields listed in Table 1 is processed in the plant. As indicated by this table the plant is utilizing and conserving 31 million cubic feet daily of casinghead gas from the Webster, East Clear Lake and Dickinson-Gillock oil fields that had formerly been flared as waste.

Process

A low concentration of product components in the casinghead and gas well gas required design of the plant for a high absorption efficiency and complete deethanization of the final product stream. Maximum operating efficiency was obtained by removing the

Flow Sheet of Humble's Clear Lake Gasoline Plant

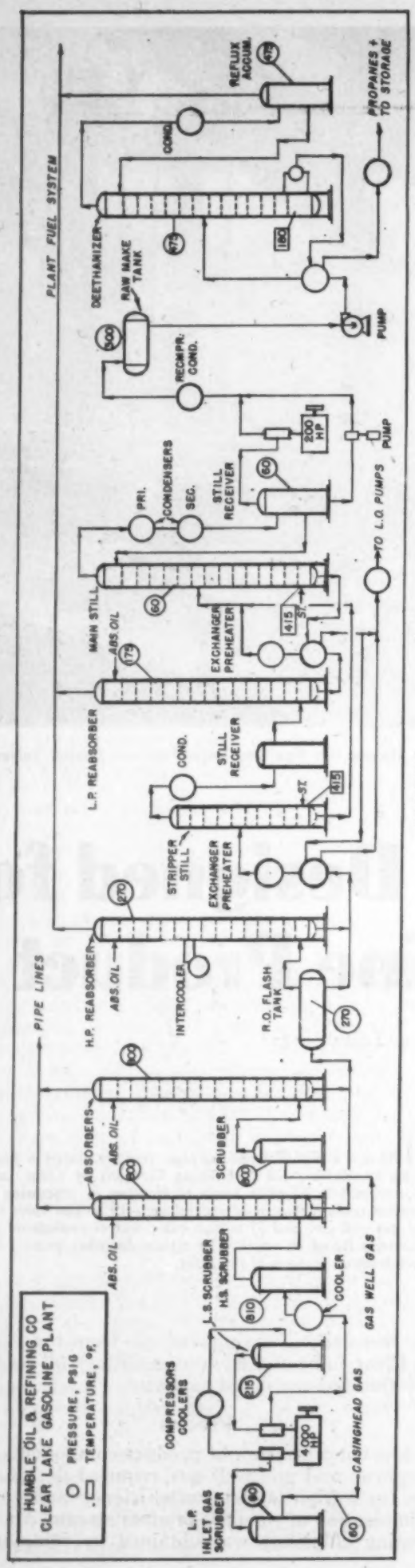


FIGURE 1

TABLE 1

OIL WELL GAS		GAS WELL GAS	
FIELD	Volume MCF Daily	FIELD	Volume MCF Daily
Webster	20,000	Halls Bayou	4,000
East Clear Lake	5,000	Dickinson	15,000
Dickinson-Gillock	6,000		
Total	31,000	Total	19,000

undesirable components of the rich oil stream by flashing the oil, reabsorbing butane and propane and some ethane from the flashed vapors, heating and then recombining and partially stripping the stream in the stripper still, reabsorbing the propanes and venting additional ethane, and separating the absorption oil and product in the main still. A single fractionation tower is required for final deethanization of the product.

Casinghead gas flows to the plant compressors at 60 psig. Compressor horsepower totals 4000 for this service. The gas is compressed in two stages from 60 to 215 psig and from 210 to 800 psig and then flows to the casinghead gas absorber. Gas well gas is available at 800 psig and after scrubbing flows to the second absorber as shown on the flow sheet of Figure 1.

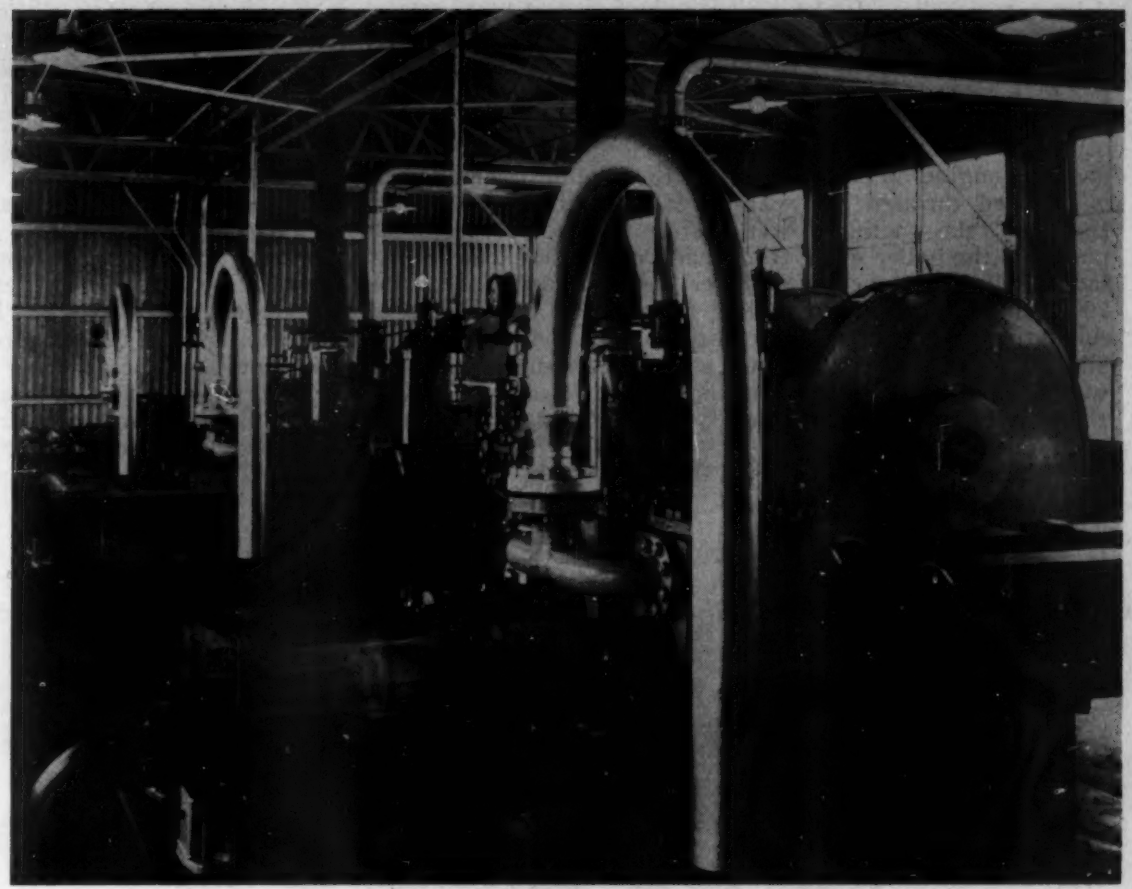
Rich oil from the absorbers at approximately 800 psig flows to the oil flash tank where it is flashed at 270 psig. This flash releases methane, ethane, propane, and some butanes and heavier components. The vapors from the flash tank flow to the high pressure reabsorber and are contacted with lean absorption oil to recover propane and butanes. The high pressure reabsorber residue gas is used in the plant fuel system. Then the rich oil streams from the flash tank and reabsorber are recombined and heated by exchange with the lean oil from the main still and with steam in a preheater for charging to the stripper still.

The stripper still operates at 175 psig and 415° F. with steam agitation and stripping to remove additional methane and ethane from the rich oil stream. Overhead vapors, containing some propane and heaviers from the stripper still, are cooled to recover the condensables, and the vapors from the still receiver are contacted with lean absorption oil in the low pressure reabsorber to recover the propane. The rich oil from the reabsorber is heated by exchange with hot lean oil and steam, recombined with the rich oil stream from the stripper still and charged to the main still. Lean oil from the bottom of the main still returns to the absorption cycle.

Recompressor Used

The total overhead from the main still is cooled in primary and secondary condensers and collected in the still receiver. As noted on the flow diagram, a recompressor is utilized to compress the still vapors to 300 psig, which vapors are combined with the liquid pumped from the still receiver into the raw make tank where total condensation is obtained at this pressure. Final deethanization of the single product is accomplished in the deethanizer columns operated at 475 psig and 280° F. The methane, ethane, and some propane are taken overhead from the column to the plant fuel system, and the product from the bottom is passed to storage.

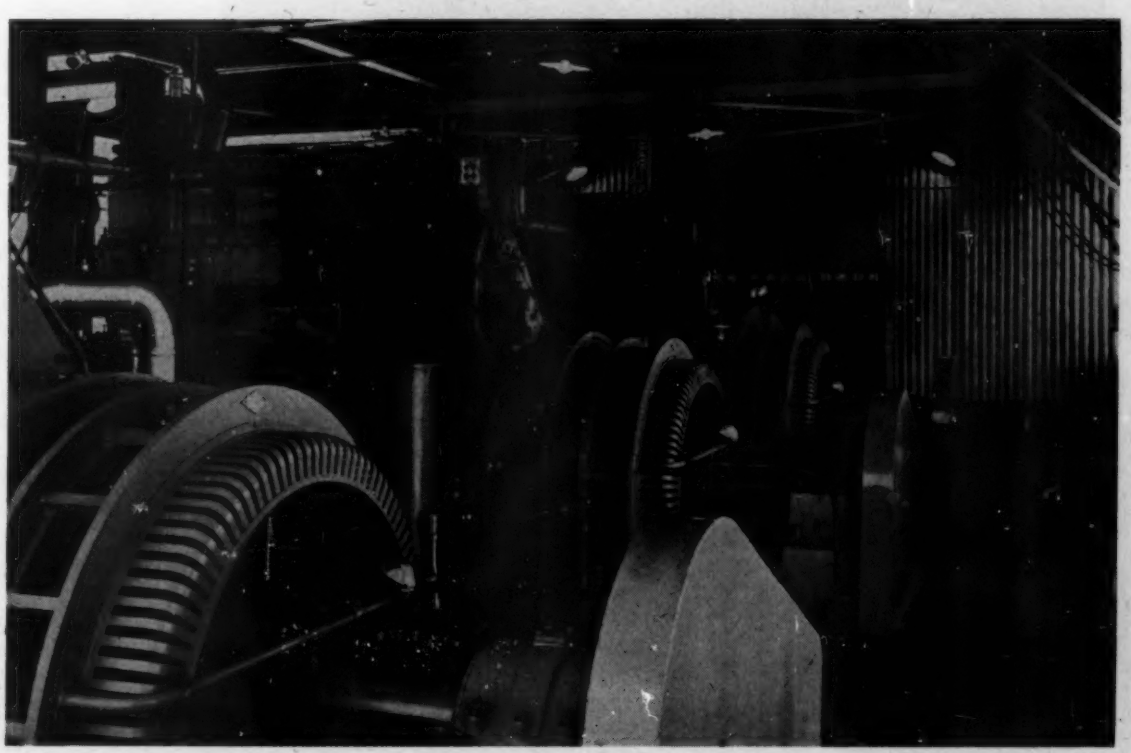
The plant steam requirements are supplied by three 150 hp., 350-pound working pressure, welded oil field type boilers at a rate of 25,000 pounds per hour. Steam at 300 psig is used in the preheaters,



Interior of the pumphouse showing the high pressure lean oil pumps which supply absorption oil to the two absorbers at 800 psig.

reheaters, and reboilers; 250-pound steam drives the reciprocating pumps and exhausts into the third system at 60 pounds, which is used for stripping in the main still. Condensed steam is recovered in a condensate accumulator, skimmed of contaminating oil, and pumped to the deaerating feedwater heater. High pressure condensed steam is passed through a partial condenser and then pressured to the deaerating heater. Use of this method requires only 8 to 10 percent raw water makeup.

A generator plant consisting of three 250-kw., 440-volt, 60-cycle gas engine driven generating units supplies electric power for the plant and camp. Automatic synchronizing devices on the switchboard, in addition to the conventional breakers, indicators, and meters, simplify operation of the units. The generator



The plant generator house contains three 250-kw., 440-volt, 60-cycle gas engine driven generating units that supply electric power for the plant and camp. On the switchboard in the background of the picture are synchronizing devices, breakers, indicators, and meter that aid in simplifying operation of the units.

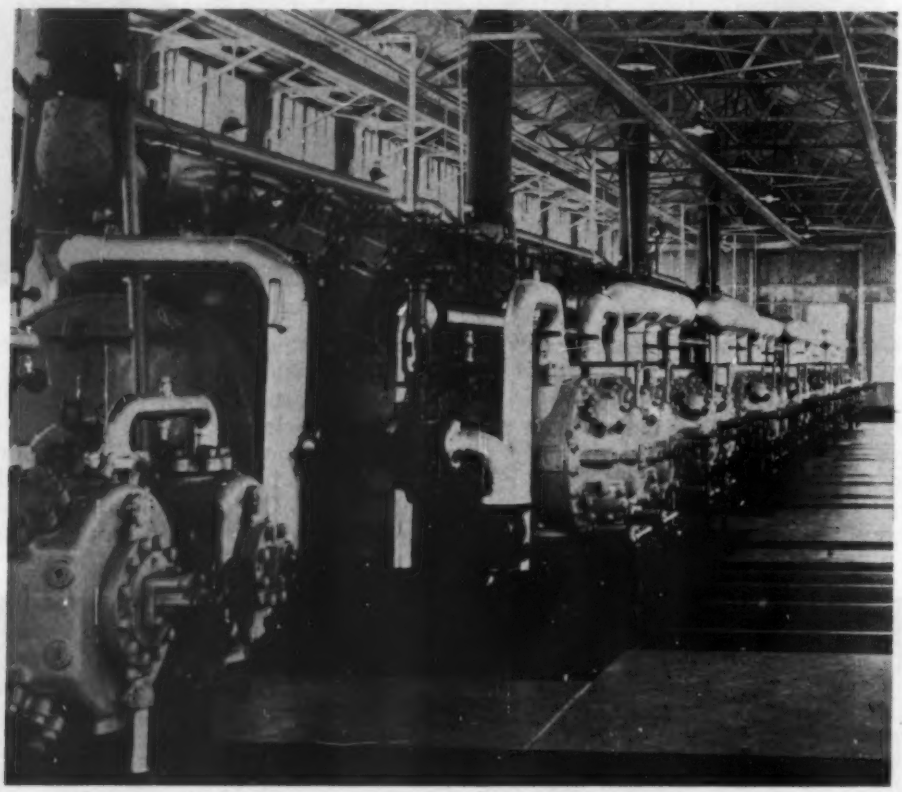
drivers are equipped with low oil pressure and high water temperature alarm systems.

Two deep wells supply the plant water of 3.5 grains per gallon hardness. The water is pumped from one well by an electric motor driven pump and from the other by a combination drive—electric motor or gasoline engine. Makeup water for the cooling tower is pumped through the reabsorber intercooler and then into the cooling tower basin. A side stream passes to the boiler water feed tank for make up. The induced draft type cooling tower has a capacity of 7000 gallons per minute cooling from 100 to 85° F. A continuous vacuum type chlorinator has been installed to control algae and a metered purge is wasted constantly to prevent the dissolved salts in the water from concentrating over four times the original content.

In the event of an emergency, the plant can be shut down from any one of six automatic shut down stations that are located at strategic points throughout the plant. Piston-type block valves and motor valves, operated by gas pressure, shut off the high and low pressure inlet and residue gas lines, vent high pressure gas to the flare, shut off fuel gas to the compressors, generator engines, lean oil pump engines, and the boilers. Snuffing steam is also turned into the boiler fire boxes.

Liquid level alarms and automatic liquid dump valves are provided for all compressor suction scrubbers. In the event of a dangerous liquid level, a float operated switch grounds the magnetos and stops the compressor engines. The absorber residue gas scrubbers are protected in the event of oil accumulation by an automatic liquid dump and alarm system.

The plant was built for Humble by Gasoline Plant Construction Company of Houston.



Line of Compressors in the Compressor House. A total of 4000 horsepower is used for compressing 31 million cubic feet daily of casinghead gas through two stages from 60 to 800 psig.

A Rapid Calculation of the Specific Dispersion of Saturated Hydrocarbons

S. G. HINDIN
Houdry Process Corporation, Marcus Hook, Pa.

WITH the customary methods of chemical analysis of gasolines, as indicated, for example, in the excellent paper by Kurtz, Mills, Harvey, and Lipkin,[1] no attempt is made to analyze for specific compounds. Instead, four major classes of hydrocarbons are determined—paraffins, C_nH_{2n+2}; naphthenes, C_nH_{2n} olefins, C_nH_{2n}; and aromatics, C_nH_{2n-6} (for alkyl benzenes). Other classes of compounds may be present, in small amounts, but, for purposes of this discussion, they will be disregarded.

As pointed out in the paper by Kurtz, et al, paraffins and naphthenes are determined after unsaturates (olefins and aromatics) have been removed. When "chemical" methods are used to remove unsaturates (treatment with a sulfuric acid—phosphorus pentoxide solution), it is desirable to make certain that the saturate raffinate retains, at most, only negligible amounts. Measurement of specific dispersion of the saturate raffinate is a simple, rapid method for determining completeness of removal of olefins and, especially, aromatics.

The dispersion of a compound is a number that is merely the numerical difference between its refractive indices when measured at two different wave lengths of light, both measurements being made at the same temperature. This value divided by the density of the compound, measured at the same temperature, is known as the specific dispersion. (For petroleum work, when the term "specific dispersion" is used, it implies refractive index measurements at wave lengths 6563 A° and 4861 A°, and at the temperature 20° C. For convenience, the value is multiplied by 10.[4])

Since the specific dispersion of a compound is related to its electronic configuration, members of the same hydrocarbon class show essentially similar values; different hydrocarbon classes show different values. Thus saturates (i.e., paraffins and naphthenes) have specific dispersions of the order of 98-99, olefins 120, alkyl benzenes 175-190. Based on this, Grosse and Waekher[2] have published a widely used method for determination of aromatics in gasolines.

The method used in this laboratory for determining essentially complete removal of unsaturates after acid treatment is measurement of the specific dispersion of the raffinate.

When using a refractometer designed for monchromatic light, the dispersion is directly calculated. However, using an Abbé type instrument with white light, the dispersion is calculated as a function of refractive index and drum reading. Such calculation is rather tedious and unnecessary when the only question is whether or not the sample is substantially aromatic and olefin-free.

For the past several years, this laboratory has used a simple chart to determine: 1) whether or not the specific dispersion of the saturate raffinate falls in the range 95-100 (x 10^4), and 2) the actual specific dispersion of the sample to ± 1 unit. The chart is prepared in the following manner (drum readings used are for the Valentine refractometer):

The refractive index and drum readings are arbitrarily taken as, respectively, 1.350 and 42.00. The dispersion is then calculated in the customary manner. Knowing the dispersion, one calculates the density required to give a specific dispersion of 95 and that required for a value of 100 (for that is the spread in values permitted in this laboratory for the saturate portion). In like manner, the table is extended from a refractive index of 1.350 to 1.510, and drum readings from 42.00 to 43.00. With instruments of make other than the Valentine model, the values used in calculation will be different, but the principle is still the same. Table 1 is a portion of the chart used in this laboratory.

TABLE 1
Limits of Density of the Saturate Raffinate

Refractive Index	DRUM READINGS				
	42.00	42.05	42.10	42.15	43.00
1.350	.684-.719	.678-.713	.672-.707	.666-.701	.558-.586
1.360	.692-.728	.685-.720	.680-.715	.674-.709	.566-.595
1.370	.700-.737	.694-.730	.688-.723	.682-.717	.575-.605
1.380	.712-.749	.706-.743	.700-.737	.694-.730	.587-.618
1.390	.722-.760	.716-.753	.710-.747	.704-.747	.599-.630
1.510	.942-.991	.936-.985	.931-.980	.926-.974	.835-.879

To use the chart, the refractive index and drum reading are noted for the sample. The density, as previously determined, must then fall within the limits given: a lower value for the density gives a specific dispersion value > 100, thus indicating the presence of unsaturates, a higher value indicates a specific dispersion < 95, showing an error somewhere in the work.

If an actual value of specific dispersion is required, the density figure may be interpolated to yield a result within 0.5 units of the determined value. A few illustrations may be given:

Sample No.	$^{20}n_D$	Drum Reading	$^{20}d_4$	SPECIFIC DISPERSION	
				Determined	From Chart
1163A7	1.4180	42.23	.746	98.0	98
1259A	1.4000	42.25	.713	98.7	99
1137A3	1.3737	42.47	.658	98.1	98

REFERENCES
[1] Anal. Ed. 19, 175(1947).
[2] Anal. Ed. 11, 614(1939).

Big Spring, Texas, city disposal plant (foreground) with Cosden Oil Company refinery in background (left, center, over the truck).

Utilization of Disposal Plant Effluent in Refinery Cooling Water Systems

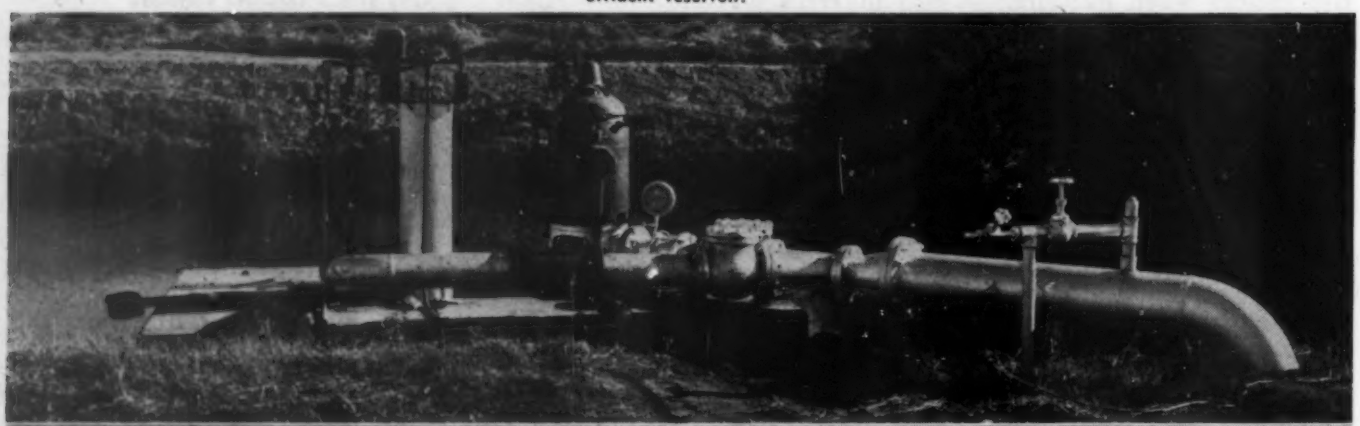
GORDON W. ALEXANDER
Associate Editor

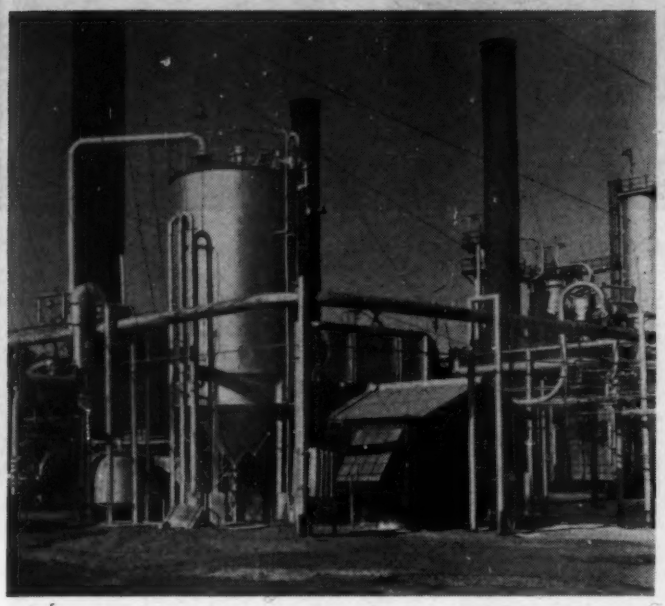
THE problem of a sufficient water supply source for refinery use is of paramount importance to the refineries located in the lower plains section of West Texas. Frequently because of this these plants virtually are on a day-to-day basis of operation.

The unique solution effected by the engineering department of Cosden Petroleum Corporation and the conditions resulting will be of interest to refineries with a similar problem.

THE problem of a sufficient water supply plagues the majority of refineries in the lower plains section of Mid-West Texas. At best the annual rain-fall is sparse and falls during a limited period, so that the problem of establishing sources of water supply for

Top view, effluent reservoir pump installation which pumps effluent through the 6000-foot pipe line to the refinery. Bottom view, disposal plant effluent reservoir.





Water softener installation at refinery.

the section in general, both the industrial and community use, is acute.

During 1943, with the advent of numerous military installations and with increases in civilian population, the demand for water reached serious proportions. At the Big Spring, Texas refinery of Cosden Petroleum Corporation the situation was such that the refinery was practically on a day-to-day basis of operation. The water supply for the refinery was obtained from numerous small wells located to the north of the refinery. A well capacity of 20 gallons per minute was considered excellent, but in spite of continuous drilling and exploration the supply was never adequate to meet the demands.

The physical characteristics of the water were such that constant chemical treatment was necessary. The water was extremely hard, the soap hardness ranging from 20 to 60 grains per gallon, which caused serious difficulties to be encountered with scale deposits in pump glands, engine water-jackets and tubular equipment. This scale was of a sulphate type and extremely hard. Consultation with water treatment experts failed to develop a chemical solvent for this scale and it was necessary to chip or scrape it from the equipment.

The cost of producing the water and piping it to the refinery was approximately 11 cents per thousand gallons. This cost was exclusive of the chemical treatment necessary to prepare the water for refinery use.

Buys Effluent from Disposal Plant

In 1944 the city of Big Spring installed a disposal unit to process the city sewerage. Upon its completion in August of that year, Cosden Petroleum Corporation contracted to purchase the effluent from the disposal plant for use as a water supply for their refinery. This source now provides both boiler feed water and make-up water for refinery cooling systems. This source of supply has proved ample and entirely satisfactory for their purposes. The effluent is fairly clear, contains only a small amount of suspended solids, and has a chlorine residual when leaving the disposal plant. There is little or no odor.

An earthen reservoir stores the effluent which is pumped 6000 feet to the refinery through a 10-inch pipe line by a motor-driven centrifugal pump. A weir gate maintains a constant level in the reservoir. The demand for the entire refinery is approximately 400 gallons per minute. Contracted effluent water price was 5 cents per thousand gallons, and actual cost of the effluent delivered to the refinery on a pay-out basis of a year for pipeline and pump installation is 7 cents per thousand gallons.

A typical analysis of the effluent is shown in Table 1.

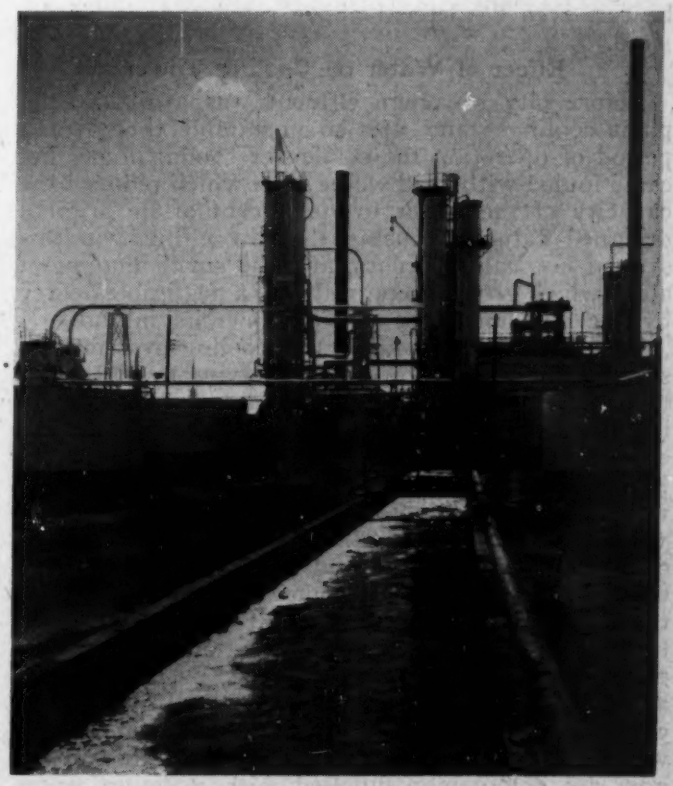
TABLE 1

	PPM
pH	8.7
Bio chemical oxygen demand	9.0
Nitrogen as ammonia	20.0
Nitrogen as nitrates	.2
Nitrogen as nitrates less than	.1
Hydrogen sulphide	.00
Suspended solids	
Phenophthalein alkalinity	25
Total Alkalinity	355
Chlorides	128

Refinery Water Systems

The three refinery water systems in operation include a steam generating system, a main process stream cooling water system, and a gas engine jacket-water system.

The steam-generating system consists of three stirling type boilers with a total rating of 1400 boiler horsepower, which is equivalent to a rated steam production of 48,250 pounds per hour; two steam generators operating from the residue and quench produced by two cracking units, designed to produce 30,900 pounds per hour. A hot-process water softener has been installed to treat the effluent. Since there is enough soap in the effluent to eliminate the necessity of adding soda ash, contacting with a lime slurry is all the treatment given to the effluent. The filter outlet has a hardness of from 10 to 15 parts per million, therefore, only a small amount of internal treatment is required to reach a zero hardness. The use of the effluent coupled with the water treating unit enables the boilers to stay on stream for a year at a time without scaling difficulties as compared previ-



Condenser water return flume to refinery water pond.

Refinery water pond at Cosden Oil Company plant, Big Spring, Texas.

ously to 20 to 30 days at which time tubular replacements were the order of the day.

The chemical savings at the boilers are apparent from Table 2 below. It can be seen that chemical costs for October are only 19.3 percent of the average cost for the first eight months of the year. This means the chemical costs at the boilers are now only about 2 percent of the total operating costs instead of about 10 percent. Based on Table 2 this saving amounts to more than $750 a month on chemicals alone.

TABLE 2

Chemical consumption at boilers	Amount
January, 1945	$ 982.15
February	845.39
March	998.67
April	1,167.03
May	905.86
June	1,015.01
July	1,089.31
August	795.46
September	528.63
October	188.20

The average monthly cost of chemicals for operations in 1947 is $220 as compared with $974 monthly average for the twelve months prior to the use of the disposal unit effluent.

The cooling system for plant process streams comprises an 8000-gpm, induced-draft cooling tower and two 10,000-gpm, centrifugal pumps driven by gas engines.

Although the engine driven pumps are rated at 10,000 gpm each, water flow was limited to 4500 gpm by the water scaling difficulties. The pump which charges the water over the cooling tower can now be run even 25 percent above rated capacity if desired.

Effect of Water on Cooling Tower

Before city sewerage effluent was available, the plant cooling water was so unsuitable that over a period of operation the condenser cooling tower became fouled with hard water scale which reduced the capacity of the tower to 70 percent of its original designed value. By using the raw effluent in this system no scaling occurs, and the small amount of algae which grows is controlled to a negligible degree by the occasional use of a commercial inhibitor.

The gas engine jacket water cooling system consists of two cooling towers, one serving to cool water to a compressor and four gas engines used with cracking units, the other for water supplied to two gas engines employed in a cooling water pumphouse. Prior to the use of the effluent, the former system was supplied by blow-down water from the boilers which was of zero hardness but had considerable quantities of dissolved and suspended solids. Although this system was somewhat expensive from the standpoint of maintenance, it caused no limitation in pumping capacities. The latter system, however, supplied by hard water, was limited considerably by the scaling tendency of the water which caused severe overheating in the engines when they were operated near their rated speed. Both systems now are completely supplied with make-up water from disposal plant effluent, this material being first subjected to a water-softening treatment. More important than the elimination of troublesome and expensive engine maintenance is the fact that the cooling water engines can now be operated at their rated speed which results in obtaining the rated delivery from the pumps instead of only 45 percent of rated delivery.

Long Runs Now Realized

Among savings difficult to evaluate accurately is the benefit derived by the gas engine-driven hot oil pumps through having soft water for jacket cooling. A number of times during the past the cracking units have been forced down because of overheated engines caused by scaling from the hard water. Obviously, a cracking unit shut-down through such causes means extra expense because of lost operating time, as well as increased maintenance. At even more frequent intervals it was necessary to shut down the cooling water pump engines for the same reason, thus causing expensive maintenance on the engines as well as expensive operation of 600 horsepower electric driven stand-bys.

Through the maintenance of a low number of cycles concentration in the cooling water system excessive scaling tendencies are now eliminated. What scale that is formed in tubular equipment can easily be removed either with 500 psi water jets or an 18 percent hydrochloric acid solution. Emphasis is placed upon the fact that the high pressure water jets have proved to be a very satisfactory method of mechanically cleaning the submerged coils in open box coolers.

Since the above difficulties have been eliminated long runs on all units have been realized.

Cooling tower return flume to refinery water pond.

Safety Is No Accident

At Ashland Oil & Refining Company's Plant

F. J. SLUZE, Safety Director, Ashland Oil & Refining Company

IN CARRYING out the accident prevention program at No. 1 Refinery of Ashland Oil & Refining Company, we proceed in the knowledge that the latent ability to prevent accidents is present, that 90 percent of preventable accidents are the result of unsafe acts, and that accident prevention not only is humane but also is profitable business. These three beliefs dominate the safety thinking of our entire organization—top management, local management, and employes.

Craft safety committee meeting

Top management gives frequent evidence of its belief and interest in these premises through messages containing such statements as:

"Each department head, each foreman, and each individual in the organization will focus more attention on safety," and "It is only when an organization becomes safety-minded—every man a safety man—that we can hope to reach the goal of accident-free operation."

But what is highly important is the fact that employes have demonstrated their acceptance by actively responding to management's appeal.

The mechanics of the program do not involve any quick cure-all for accidents. However, it has been effective through work with publicity, inspections, careful instruction and training, safety contests, vigilance, and steady, consistent work.

Supervisors are much like those of any other refinery. They do not want accidents and would like to eliminate them if possible. They hate pencil work or book work, especially making a written report covering an accident. They would like to give safety more attention, but have other duties that need their attention also. They get tired drumming on safety all the time, and must be stimulated.

Our employes are not different from those of other refineries. They do not want to be injured. They do not wilfully perform unsafe acts. They think that the other fellow may get hurt but that they themselves will not be so "unlucky." They think that unsafe conditions will cause an injury, but are not fully aware of the importance of unsafe acts as a cause. Many of them do not comprehend the meaning of frequency and severity, so the supervisor or safety authority may just as well omit its use as much as possible unless they go to great length in explaining its meaning. National figures convey very little to them expressed in large numerical terms. They react passively to safety speeches or addresses of a general nature, but do react actively if permitted to take part in the discussions. And lastly, they too get tired of constantly being remanded of safety, and they must be stimulated.

So with the above material to work with, we try to be realistic and depend more on making safety an integral part of the job rather than making safety some separate and distinct activity that needs high-pressured salesmanship to assure its existence.

True, we do resort to some ballyhoo, also sales promotion and "revival" tactics. How could wholesale cooperation be maintained without it? But these approaches are for stimulation rather than glorifying accident prevention as a separate activity.

We employ all the usual "tricks of the trade" such as: bulletin service emanating from the National Safety Council, Elliott Service Company, American Petroleum Institute, National Petroleum Association, the company's insurance carrier and others.

We also are running three safety contests, the first one between our company and the 27 others enrolled in the medium-sized group under the auspices of the National Safety Council; the second one is an intra-company contest between the major departments, while the third is an intra-refinery contest between the several crafts or refinery departments.

Competitive scoreboards showing the number of days worked since the last lost-time injury operate in the different refinery sub-divisions. A specific man is delegated the job of posting the scoreboard daily.

A master scoreboard showing the number of days since the last lost-time accident for the refinery is maintained at the plant entrance.

Employes' plant-inspection committees make an inspection once each month in company with the safety director, who guides and directs their inspection. One of the employes acts as secretary, making pencil notes as the party calls out the discrepancies. Copies of these notes are sent to members of the inspection committee and the supervisory force.

We do not have a formal suggestion system but do get splendid cooperation from the men who are constantly making verbal suggestions to their foremen

AOBCo. AV 1000 1M 5-45-G (75541)

PERMIT TO ENTER VESSEL OR TANK

NEW PERMIT MUST BE OBTAINED AT SHIFT CHANGE

Date _____ Shift _____

Vessel or Tank to be Entered _____

Description of Work to Be Done _____

_____

ANSWER YES OR NO: Vessel Completely Blanked Off _____, Vessel Steamed _____;

All Manheads Open _____; Vessel Ventilated _____; Vessel Gas Free _____.

VESSEL TESTED BY: _____

SIGNATURE OF TESTER

If any of the above are NO, give reason why _____

_____

The following safety appliance should be utilized upon entering vessel _____

The following safety appliance should be available before entering vessel _____

OPERATOR IN CHARGE: _____

NOTE: Make three (3) copies: (1) One copy to foreman performing work. *(2) One copy to man entering vessel (3) One copy to be retained by operator in charge of area.

*Man entering vessel to return his permit to Safety Dept. at end of his shift.

INSTRUCTIONS (FOR HAZARDOUS WORK)

1. Shift Superintendent's request for repairs will be executed before attempt at repairs is started.
2. Premises will be in satisfactory condition for work to be done.
3. A fire extinguisher and if possible, a steam hose and nozzle, will be kept in readiness while the job is going on.
4. All traces of flammable or noxious gases will be removed before starting repairs.
5. Major repairs or changes will be in accord with directions of the General Superintendent.
6. Maintenance men (electricians, welders, etc.) while engaged in this work, are under the jurisdiction of the Shift Superintendent as well as their own foreman as it pertains to their safety.
7. Safety tools will be used where conditions require them.
8. The maintenance foreman will assure himself that equipment is operating properly after repairs have been made.
9. Tests for flammable gases will be made by a competent person with a mechanical detector.
10. Precautions will be taken to permit only authorized persons to enter the vicinity by placing a warning sign stating — "Warning Keep Away — Hazardous Work Going On".
11. All Lines leading into such vessel will be completely drained.
12. As an added precaution — all lines leading into such vessel will be completely blanked.

The lower photograph shows setup for air supply for the men entering a tank, wearing gas masks. The upper picture shows the author of this article making a gas test with petroleum vapor indicator. The blanks (reduced from 6 by 3½ inch forms) are used as the wording of them indicates.

or safety director. This is a very good criterion of their safety attitude since no special prizes or awards are given these men except a sincere follow-up to their suggestions. We endeavor to evidence our sincerity by reporting back to the employe when his suggestion has been accepted and completed, tactfully telling the worker whenever a suggestion is far fetched, uneconomical, or impractical, and reporting back to him whenever his suggestion has been tabled or pending.

Safety committee meetings are held twice a month. Each craft or refinery department has its own meeting, where a chairman and secretary selected by the men conduct the meeting. At this meeting a regular order of business is followed, the program being as follows:

Chairman calls the meeting to order.

Secretary reads the minutes.

Secretary reads all safety communications and bulletins.

A report is then given the men by the safety director.

Next comes description of recent accidents and a discussion as to cause and remedial measures.

The foreman in charge is then called upon for remarks.

Suggestions concerning plant improvement and safety by individual members. (The chairman calls on each member present who either reports, "No suggestion" or any he has on his mind.)

The chairman adjourns the meeting until the next regular date.

About every three months a guest speaker is brought in to address a mass meeting of all employes. This speaker may be from another refinery or he may be from one of the other industries in our area.

Orientation of New Men

Orientation procedure begins in the Personnel Department and ends with the safety director escorting the new man around the refinery. The first job the safety director does with the new man is to get a line on his previous background. Having obtained this, he builds around the new man's background, explaining to him the similarity or difference between his previous work and his new job. Plant regulations are explained to him one by one, giving the reasons for these regulations. The operation of first-aid, fire-extinguishing equipment is explained simply and in detail. On the trip around the plant the new man is shown the different buildings and units he will have to know to perform his job. He is also shown the location of major fire-extinguishing equipment and how to turn in a fire alarm. While in the operating area, a general explanation of the processing is given to him. The new man is cautioned to go about his work thinkingly and not to excite himself unduly because of the strange environment. He is then taken to the tool room where he is fitted up with his hard hat and eye-protection equipment, and urged

very strongly to use this protection. After assigning him to his locker, he is taken to his new supervisor. Here he is introduced with the explanation to the supervisor that the new man has gone through the established orientation procedure and is being turned over to him as a new employe with the suggestion that he "break him in" safely. The supervisor after shaking hands with the new man proceeds to acquaint him with the special safety regulations that pertain to his particular craft or department. Returned servicemen were given the same orientation as brand new men, and many of them exclaimed, "This will save me weeks of getting re-acquainted. I can see all the changes that took place during my absence in the first hour back on the job."

Wholesale first-aid training has been a very important factor in preventing accidents in the plant. A post-war program has been started by training and retraining about 60 percent of our supervisors and employes, and it is planned that all will be trained in the very near future. A trained first-aid man automatically becomes a safe worker since discussing, reviewing, and dressing hypothetical injuries sets up a defense attitude against such injuries.

Since safety at a refinery includes both injury prevention and fire prevention, we utilize this approach by having regular fire-brigade training and rehearsal. We set up hypothetical fire problems, which include the different locations and equipment in the refinery, and allow the fire brigades to actually handle the fire-fighting equipment. As often as possible services of fire-extinguishing equipment manufacturers are used to demonstrate actual performance of their equipment on a demonstration fire.

Sound slides and motion pictures procured from the National Safety Council, Bureau of Mines, Army Service Command and oil companies are put to work for injury prevention and fire prevention.

Where circumstances warrant a formal investigation, supervisors are appointed to accident-investigating committees. Not only do these supervisors learn first hand the cause of the accident, but their participation in such investigations has a psychological effect on all engaged in the investigation.

Recently we completed a series of "It Can Happen Here" bulletins to all supervisors. These bulletins described accidents that occurred at other refineries, their cause, and means of preventing their happening at our refinery. Those that contained messages appropriate for rank-and-file workers were attached to the time cards of all hourly men.

Each month every worker receives a copy of the "Safe Worker," a pamphlet published by the National Safety Council.

Supervisors receive monthly copies of "The Safe Foreman" which is supplied by the insurance carrier. Supervisors also receive monthly copies of "Industrial Supervisor," a publication of the National Safety Council. Several key officials, including the general superintendent, receive monthly copies of the National Safety News. Local bulletin service includes safety messages, accident descriptions, and personal letters from the general superintendent on local experience and topics.

The safety director at our refinery is a combination of all the levels found in the safety organizations of large manufacturing industries. He is a director, engineer, inspector, and fire-prevention authority all rolled up in one. He has no direct authority over the employes except in case of imminent danger, and works through the supervisor directly in charge. His job is chiefly consulting, advising, coordinating, "sparking the entire organization," and training of workers and supervisors in injury prevention and fire prevention. He compiles the records, statistics, diagnoses and analyzes causes, and in the end keeps management and workers posted on trends. His engineering ability is used to supplement the experience and background of direct supervision, while his inspection work is typical of that of any other safety inspector.

As a fire prevention authority, the safety director oversees the inspection and care of fire-extinguishing equipment and trains personnel in fire-fighting techniques. His job is not a white collar one; on the contrary, he is out among the men as much as possible. Hence, he dresses much the same as all other refinery men.

A great amount of emphasis is placed upon proper control of "hot work" and "entering tanks or vessels" as a means toward preventing fires, flashes, explosions, and men being overcome. The "hot-work" permit procedure is a written set-up. The foreman in charge of the equipment or area to be worked on makes request to the safety director for a written permit. The safety director then takes his petroleum-vapor indicator and makes a gas test. Finding the equipment gas free, he informs the foreman in charge of the fact. The safety director and foreman then inspect the surrounding area to see that sewers are protected, that blinds are in place, that the ground clip area is gas-free, that the welding machine is located at a safe place, that the floor or ground beneath has been thoroughly washed down, and that extinguishing facilities are on the job. The foreman then signs the permit vouching for the safety of the equipment and the surrounding conditions, and the safety director vouches for the equipment and surroundings being gas-free. One copy goes to the welder; the second copy goes to the foreman in charge of the equipment or area; while the third copy goes to the maintenance foreman. Upon conclusion of the job, the maintenance foreman completes the form, stating that the job was completed, blinds removed, and equipment returned to the foreman in charge for operation.

The "permit to enter vessel or tank" procedure is much the same as the "hot-work permit" except that the questionnaire is worded somewhat diffenertly.

All the foregoing is a general review of the safety program at Ashland Oil & Refining Company's No. 1 Refinery. It is evident that accident prevention in this plant is based upon the three premises stated in the beginning of this article. These premises are supplemented by making safety an integral part of each job, and the safety director is a roving supervisor, assisting each foreman in the organization to get the job done safely.

This plant's safety record is not the best in the oil-refining industry. We have made considerable progress in eliminating accidents, having had no lost-time accident runs of 180 days and 330 days during the past three years. We completed another run of 257 days recently, which the employes celebrated with a banquet, safety addresses, and entertainment.

It is hoped that this review of our safety program has refreshed the reader on certain approaches to accident prevention that may have been forgotten or lain dormant, perhaps it did bring out a new angle or two. If it has, then the writer will feel highly gratified in knowing that he has been able to contribute something toward the elimination of accidents.

Simplified Multi-Component Fractionation Calculations

Part I

MINIMUM REFLUX RATIO

RAYMOND V. BAILEY* and JESSE COATES**

IN THIS article several methods are presented for the calculation of minimum reflux ratio and the number of trays required in multi-component fractionation. These methods are presented as an improvement over certain previously published methods, in that the time required for calculations has been considerably shortened and the accuracy has been improved in many cases.

Part I contains a modification of the Schiebel—Montross[17] equation for minimum reflux. The temperatures are properly defined for systems in which the relative volatility varies. This modification places the calculation on a trial and error basis, but changes the reliability of the method from a maximum error of about 15 percent to about 1 percent. The accuracy is about the same as the Colburn[3] correlation, but the time required in application is much less.

In Part II (to appear in a later issue) a pseudo reflux ratio and an equilibrium curve are defined in a more accurate manner for the application of the Schiebel[16] method for tray determinations. The modified method has a maximum error of about 5 percent compared to about 20 percent for the unmodified method.

Part III (also to appear later) contains a graphical solution for tray requirements which is more advantageous than the modified Schiebel method of Part II if a heat balance around the feed point is necessary and the minimum reflux ratio is not of primary significance. In addition, the proposed method permits a check on the assumed distribution of a split key.

The graphical solution presented is somewhat similar to the method proposed by Hengstebeck[8], but with the pseudo operating lines and equilibrium curve defined in such a manner as to permit application of the method at reflux ratios near the minimum as well as reflux ratios which are large compared to the minimum.

Multi-component systems are placed on the basis of the key components by the definitions:

$$x = \frac{X_{1K}}{\Sigma X_{Keys}}$$

$$y = \frac{Y_{1K}}{\Sigma Y_{Keys}}$$

The equilibrium curve and pseudo operating lines are determined by a calculation of the composition on the feed tray and the tray above the feed.

The proposed method requires fewer calculations than the method of Jenny[20] and eliminates the trial and error in the determination of the feed tray temperature.

The maximum error is about 5 percent.

THERE exist in the literature several methods of determining the minimum reflux ratio for a multi-component system.

The rigorous method, as defined by Jenny[11] involves tedious trial and error.

Underwood[18] developed equations for the exact determination of the minimum reflux for a multi-component system based on constant volatility and complete separation. However, for most actual cases, in which the volatility is not constant, the result is only a rough approximation.

Gilliland[7] presented an equation, based on equal ratio of the keys in the two pinches, which involves trial and error if the feed condition is other than a liquid at feed tray temperature. This equation gives a limiting low value. Later Robinson and Gilliland[14] developed an equation which gave a limiting high value. The recommended procedure is to take the average of the limiting values for the true minimum reflux ratio. However, the limits are often so far apart as to leave the true minimum reflux ratio in doubt.

Colburn[3] pointed out that the ratio of the keys in the pinches at minimum reflux ratio are not equal and developed an empirical expression for the relation of the keys at minimum reflux. The relation has an accuracy of approximately one percent, but involves considerable trial and error.

Other methods[2,9] have been presented, based on the false assumption that the ratio of the keys in the pinches are equal at minimum reflux.

Schiebel and Montross[17] developed an empirical equation consisting of three terms:

1. The reflux to separate the key components, assuming that the components lighter than light key have infinite volatility and the components heavier than the heavy key have zero volatility.
2. The reflux to separate the heavier components from the overhead due to their actual volatilities.
3. The reflux to separate the lighter components from the bottoms due to their actual volatilities.

This equation is accurate within approximately one percent for systems in which the relative volatilities are constant. However, the equation needs slight modification and the temperatures must be properly defined for the cases in which the relative volatilities are not constant.

The essential equations presented by Schiebel and Montross[17] follow:

1. Pseudo ratio of liquid to vapor

$$m = \frac{M_L - \Sigma M_{hF}}{M_V - \Sigma M_{lF}} \qquad (1)$$

where

m = pseudo ratio of liquid to vapor
M_L = mols of liquid feed
M_V = mols of vapor feed
ΣM_{hF} = total mols of components heavier than the heavy key in the feed
ΣM_{lF} = total mols of components lighter than the light key in the feed

2. Definition of McCabe-Thiele type diagram on the basis of two key components as follows:

$$x = \frac{X_{1K}}{X_{1K} + X_{hK}} \qquad (2)$$

$$y = \frac{Y_{1K}}{Y_{1K} + Y_{hK}} \qquad (3)$$

where

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x = equivalent liquid composition based on the key components only
y = equivalent vapor composition based on the key components only
X_{lK} = liquid composition of the light key
X_{hK} = liquid composition of the heavy key
Y_{lK} = vapor composition of the light key
Y_{hK} = vapor composition of the heavy key

3. Empirical equation for minimum reflux ratio

$$R_M = \frac{1}{M_{lKF} + \Sigma M_{lF}} \left[M_{lKF} R'_M + \frac{M_{hKF} + \Sigma M_{hF}}{M_F} \sum \frac{M_{hF}}{\frac{K_{lK}}{K_h} - 1} + \sum M_{lF} \left(\frac{1 + \frac{K_{lK}}{K_l}}{\frac{K_l}{K_{hK}}} \right) \right]$$

where

R'_M = pseudo minimum reflux ratio based on the key components, determined from the McCabe-Thiele type diagram defined, using the pseudo ratio of liquid to vapor.
R_M = true minimum reflux ratio
M = mols
K = equilibrium constant Y/X

Subscripts:

F = feed
h = component heavier than the heavy key
l = component lighter than the light key
hK = heavy key component
lK = light key component

The pseudo minimum reflux ratio, R'_M, gives the mols of reflux per mole of the key components overhead, but is used in the equation by Schiebel and Montross[17] as if it were mols of reflux per mole of the light key in the feed. The two may be equal in many cases, but not in all cases. Similarly, the correction term for the heavy components,

$$\frac{1}{M_F} \sum \frac{M_{hF}}{\frac{K_{lK}}{K_h} - 1}$$

is reflux per mole of bottoms; therefore, the equation should read as follows:

$$R_M = \frac{1}{D} \left[M_{KD} R'_M + \frac{W}{M_F} \sum \frac{M_{hF}}{\frac{K_{lK}}{K_h} - 1} + \sum M_{lF} \left(\frac{1 + \frac{K_{lK}}{K_l}}{\frac{K_l}{K_{hK}}} \right) \right] \quad (4)$$

Where

D = total mols of overhead
M_{KD} = total mols of the key components overhead
W = total mols of bottoms

Temperatures for Pseudo Minimum Reflux

The purpose of the pseudo ratio of liquid to vapor is to correct the operating lines to a basis which will permit the use of the McCabe-Thiele type diagram defined. However, this pseudo ratio of liquid to vapor does not correct the equilibrium curve for the presence of the light components, whose relative volatility is assumed to be infinite, in the vapor and the heavy components, whose relative volatility is assumed to be zero, in the liquid of the fractionating and stripping sections respectively.

For the stripping section, if the relative volatilities of the heavy components are assumed to be zero

$$\Sigma X_{Keys} = 1 - \frac{\Sigma M_{hF}}{L_m}$$

and for the fractionating section, assuming the light components to have infinite volatility

$$\Sigma Y_{Keys} = 1 - \frac{\Sigma M_{lF}}{V_n}$$

where

L_m = liquid downflow in the stripping section
V_n = vapor upflow in the fractionating section

Thus, the temperatures of the pinches will correspond to the reflux ratio of $\frac{M_{KD} R'_M}{D}$ with the light components in the vapor phase of the fractionating pinch and the heavy components present in the liquid of the stripping pinch.

These temperatures may be determined by rearrangement of the operating lines. Thus,

For the fractionating section pinch:

$$K_{hK} = \frac{L_n}{V_n} + \frac{D X_D}{V_n X_{hkn}}$$

NOMENCLATURE

α = Relative volatility with respect to heavy key
d = Mols of component in overhead
D = Total mols overhead
f = Function
K = Equilibrium constant = Y/X
l = Mols of component in liquid phase
L = Mols of liquid downflow in column
m = Pseudo ratio of liquid to vapor
M = Mols of component
N = Number of theoretical trays
R = Reflux ratio, mols reflux per mole of overhead
R' = Pseudo reflux ratio, mols reflux per mole of keys overhead
v = Mols of component in vapor phase
V = Mols of vapor upflow in tower
w = Mols of component in bottoms
W = Total mols of bottoms
x = Mol fraction of light key in liquid on two-component basis.
X = Mol Fraction of component in liquid phase
y = Mol fraction of light key in vapor on two-component basis.
Y = Mol fraction of component in vapor phase
z = Mol fraction of light key in vapor plus liquid on two-component basis
Z = Total mol fraction of component (liquid + vapor)

Subscripts:

D = Overhead
f = Feed tray
F = feed
h = heavy component, heavier than heavy key
hK = heavy key
i = intersection of operating lines
l = light component, lighter than light key
lK = light key
L = liquid
m = stripping section
M = minimum
n = fractionating section
t = top tray
v = vapor
w = bottoms

Superscripts:

$'$ = pseudo

and for the stripping section pinch:

$$K_{1K} = \frac{L_m}{V_m} + \frac{W X_w}{V_n X_{1Km}}$$

where $\frac{L_n}{V_n}$ and $\frac{L_m}{V_m}$ are calculated using the reflux ratio $\frac{M_{KD} R'_M}{D}$.

where

K_{hK} = equilibrium constant for heavy key component
K_{1K} = equilibrium constant for light key component
X = mole fraction in liquid phase
L = mols liquid
V = mols vapor

Subscripts:

hKn = heavy key in fractionating pinch
lKm = light key in stripping pinch
D = overhead
W = bottoms
m = stripping section
n = fractionating section

The equilibrium curve may be broken at a point between the stripping section and the fractionating section. At the pseudo minimum reflux ratio the operating lines will cross their respective equilibrium curves at the same value of "x" and intersect on the pseudo feed line between the two sections of the equilibrium curve.

The temperature for the separation of the heavier components is the temperature of the stripping column pinch at the true minimum reflux ratio, since that temperature determines the concentration of the components in the pinch and therefore the minimum reflux ratio.

Similarly, the temperature for separation of the lighter components has significance only in the fractionating pinch corresponding to the true minimum reflux ratio.

However, the correction terms are usually small and/or the variation of the relative volatility between the pinch temperatures is not great, and usually only slight error is introduced by using the "K" values at the temperatures of the pinches corresponding to the reflux ratio $\frac{M_{KD} R'_M}{D}$. If the correction factors and the variation of the relative volatility of the components are large, recourse to trial and error is necessary.

Recommended Methods of Determination of R'_M

METHOD I:

As a very close approximation, the operating lines intersect the pseudo feed line at a relative volatility of the key components which is the average of the relative volatilities of the pinches corresponding to the reflux ratio $\frac{M_{KD} R'_M}{D}$.

The equation of the pseudo feed line is given by

$$y = z_F + m(z_F - x)$$

and from the simulation of the fractionating pseudo operating line with this pseudo feed line at the pinch, eliminating *y*:

$$x_i = \frac{z_F (1+m) - \frac{x_D}{R'_m + 1}}{\left(\frac{L_n}{V_n}\right)' + m} \qquad (5)$$

where

x_i = liquid composition on basis of the key components at the intersection of the pseudo operating line and the pseudo feed line.
z_F = mole fraction of light key in the feed on basis of the key components.
m = pseudo ratio of liquid to vapor.
x_D = mole fraction of light key in overhead on basis of key components.
R'_M = pseudo minimum reflux ratio.
$\left(\frac{L_n}{V_n}\right)'$ = pseudo ratio of liquid to vapor in fractionating section.

If m equals infinity, then $x_i = z_F$.

From Fenske[4] equation for binary mixtures:

$$R'_M = \frac{1}{\alpha_{avg} - 1}\left[\frac{x_D}{x_i} - \alpha_{avg}\left(\frac{1 - x_D}{1 - x_i}\right)\right] \qquad (6)$$

where

$$\alpha_{avg} = \frac{\alpha_n + \alpha_m}{2}$$

α_n = relative volatility of the key components at the fractionating pinch corresponding to a reflux ratio $\frac{M_{KD} R'_M}{D}$

α_m = relative volatility of keys at the stripping pinch corresponding to a reflux ratio of $\frac{M_{KD} R'_M}{D}$

The relative volatilities at the pinches may be determined by noting that a rearrangement of the operating lines at the pinches gives:

For fractionating section

$$K_{hK} = \frac{L_n}{V_n} \text{ Approx.} \qquad (7)$$

For stripping section

$$K_{1K} = \frac{L_m}{V_m} \text{ Approx.} \qquad (8)$$

To calculate R'_M:

1) Assume a value of R'_M;
2) Calculate x_i by equation 5;
3) Calculate the average relative volatility;
4) Calculate R'_M by equation 6;
5) Use calculated value of R'_M for second assumption and repeat until assumed R'_M equals calculated R'_M.

Usually the second trial is sufficient since the convergence is very rapid.

It must be emphasized that this method is only approximate and therefore should be used only to obtain a first assumption for Method II if the separation is extremely poor or if the relative volatility of the keys is below 1.5 with a large spread between the pinches.

METHOD II:

The pinch compositions are calculated assuming the light components have infinite volatility and the heavy components have zero volatility. Trial and error is used until the ratio of the liquid concentrations of the key components in the two pinches are equal, which must be the case for a binary system.

The operating lines, at the pinches, may be written in the following form:

$$X_n = \frac{X_D}{K + (K-1)\frac{L_n}{D}} \qquad (9)$$

$$X_m = \frac{X_w}{K + (1-K)\frac{L_m}{W}} \qquad (10)$$

where

X_n = concentration of a component in the fractionating pinch

X_m = concentration of a component in the stripping pinch

K = equilibrium constant of component in question

L_n/D = ratio of moles of liquid in fractionating section to moles of overhead

L_m/W = ratio of moles of liquid in stripping section to moles of bottoms

X_D = mole fraction of component in question in overhead

X_w = mole fraction of component in question in bottoms

At the pinches, since the light components have infinite volatility and the heavy components are considered to have zero volatility

$$\Sigma X_n = O \text{ for the light components} \quad (11)$$

$$\Sigma Y_n = \frac{\Sigma M_{1F}}{V_n} \text{ for the light components} \quad (12)$$

$$\Sigma X_m = \frac{\Sigma M_{hF}}{L_m} \text{ for the heavy components} \quad (13)$$

$$\Sigma Y_m = O \text{ for the heavy components} \quad (14)$$

and for this case, at a reflux ratio of $\frac{M_{KD} R'_M}{D}$

$$\frac{r_m}{r_n} = 1.00 \quad (15)$$

where

r_m = ratio of the key components in the liquid phase at the stripping pinch

r_n = ratio of the key components in the liquid phase at the fractionating pinch

For purposes of illustration the debutanizer example of Schiebel[16] will be used

Sample Calculation

EXAMPLE 1

	Mols Feed	Mols Overhead	Mols Bottoms
C_3	1.0	1.0	....
C_4	40.0	39.4	0.6
C_5	23.0	.4	22.6
C_6	16.0	....	16.0
C_7	12.0	....	12.0
C_8	8.0	....	8.0
	....	40.8	59.2

Feed at 220° F.
Mols Liquid..... 75.0
Mols Vapor..... 25.0
Operating pressure..... 100 psia.
Equilibrium constants are from the Nomograph in the same article [16].

Determination of R'_M

METHOD I:

Assume $\frac{M_{KD} R'_M}{D} = 1.4$

then $R'_M = \frac{1.4D}{M_{KD}} = \frac{(1.4)\ (40.8)}{39.8} = 1.435$

from equation (7)

$$K_{c3} = \frac{(1.4)\ (40.8)}{(2.4)\ (40.8)} = 0.583 \text{ approx. in fract. pinch}$$

$K_{c4} = 1.38$ at the temperature at which $K_{c3} = 0.583$

This allows relative volatility at the upper pinch to be calculated.

From equation (8)

$$K_{c4} = \frac{(1.4)\ (40.8) + 75}{(2.4)\ (40.8) - 25} = \frac{L_m}{V_m}$$

$= 1.811$ approximate in stripping pinch

$K_{c3} = 0.82$ when $K_{c4} = 1.811$

$$\alpha_n = \frac{1.38}{0.583} = 2.365$$

$$\alpha_m = \frac{1.811}{0.82} = 2.21$$

$$\alpha_{avg} = 2.288$$

From equation (1)

$$m = \frac{M_L - \Sigma M_{hF}}{M_V - \Sigma M_{1F}} = \frac{75 - 36}{25 - 1} = 1.622$$

$$x_D = \frac{39.4}{39.4 + 0.4} = 0.99$$

$$z_F = \frac{40}{40 + 23} = .635$$

Using equation (5)

$$x_1 = \frac{(0.635)\ (2.622) - \frac{.99}{2.435}}{\frac{1.435}{2.435} + 1.622} = .572$$

From equation (6)

$$R'_M = \frac{1}{1.288}\left[\frac{.99}{.572} - 2.288\left(\frac{.01}{.428}\right)\right] = 1.30 \text{ first approximation}$$

Assume $R'_M = 1.30$

Then $\frac{(M_{KD})\ (1.30)}{D} = \frac{(39.8)\ (1.30)}{40.8} = 1.27$

Fractionating pinch:

$$K_{c3} = \frac{1.27}{2.27} = .56 \ ; \ K_{c4} = 1.33$$

Stripping pinch:

$$K_{c4} = \frac{(1.27)\ (40.8) + 75}{(2.27)\ (40.8) - 25} = 1.87 \ ; \ K_{c3} = .85$$

$\alpha_n = 2.375$
$\alpha_m = 2.200$
$\alpha_{avg} = 2.287$

$$x_1 = \frac{(.635)\ (2.622) - \frac{.99}{2.3}}{\frac{1.3}{2.3} + 1.622} = .570$$

$$R'_M = \frac{1}{1.287}\left[\frac{.99}{.57} - 2.287\left(\frac{.01}{.43}\right)\right] = 1.31$$

$$\frac{M_{KD} R'_M}{D} = \frac{(39.8)\ (1.31)}{40.8} = 1.28$$

METHOD II:

As a first assumption:

$$\frac{M_{KD} R'_M}{D} = 1.28 \text{ from Method I.}$$

$$\frac{L_n}{V_n} = \frac{1.28}{2.28} = .561 = \text{Approximate } K_{c3} \text{ at fractionating pinch}$$

$V_n = (2.28)\ (40.8) = 93.0$
$L_m = (1.28)\ (40.8) + 75.0 = 127.2$

$$\frac{L_m}{V_m} = \frac{127.2}{68} = 1.871 = \text{Approximate } K_{c4} \text{ at stripping pinch}$$

$$\frac{L_m}{W} = \frac{127.2}{59.2} = 2.15$$

Pinch temperatures are assumed using the approximate values calculated above. The key components are calculated at the pinches using equations (9) and

TABLE 1

Comparison of Minimum Reflux Ratios for Section I

Problem	Reference	FEED COMPOSITION X_l	X_{lk}	X_{hk}	X_h	α_l	α_h	MINIMUM REFLUX RATIO Present Method	Colburn	Schiebel-Montross
1	....	....	.30	.30	.40	....	0.5	4.54	4.51	3.95
2	....	....	.30	.30	.40	....	0.8	5.12	5.13	4.47
3	....	.40	.30	.30	....	2.1	....	1.45	1.45	1.64
4	(15)	Dubutanizer illustrated						1.38	1.38	1.27
5	(10)	Depropanizer example of Jenny's						.95	.96	.95*

For Problems 1, 2 and 3 the K values for the keys are given in Figure 1. Only a trace of the heavy key goes overhead and a trace of the light key in in the bottons. Feed is liquid at the boiling point.

* Schiebel-Montross has compensating errors.

(10). The light and heavy components are determined from equations (11) through (14). The assumed temperatures are checked by a boiling point determination. The results are summarized below in tabular form.

Fractionating pinch:

	K_{374}	X_n	Y_n
C_3	3.29	-	.011
C_4	1.33	.551	.735
C_5	.56	*.449	.251
		1.000	.997

* by difference

Stripping pinch:

	K_{311}	X_m	Y_m	K_{310}	X_m	Y_m
C_4	1.87	*.393	.735	1.85	*.396	.732
C_5	.85	.325	.276	.84	.322	.270
C_6	-	-	-	.40	-	-
C_7	-	.282	-	.188	.282	-
C_8	-	-	-	.092	-	-
		1.000	1.011		1.000	1.002

* by difference

$$r_m = \frac{\frac{.396}{.322}}{\frac{.551}{.449}} = 1.00$$

Therefore $\frac{M_{KD} R'_M}{D} = \underline{\underline{1.28}}$

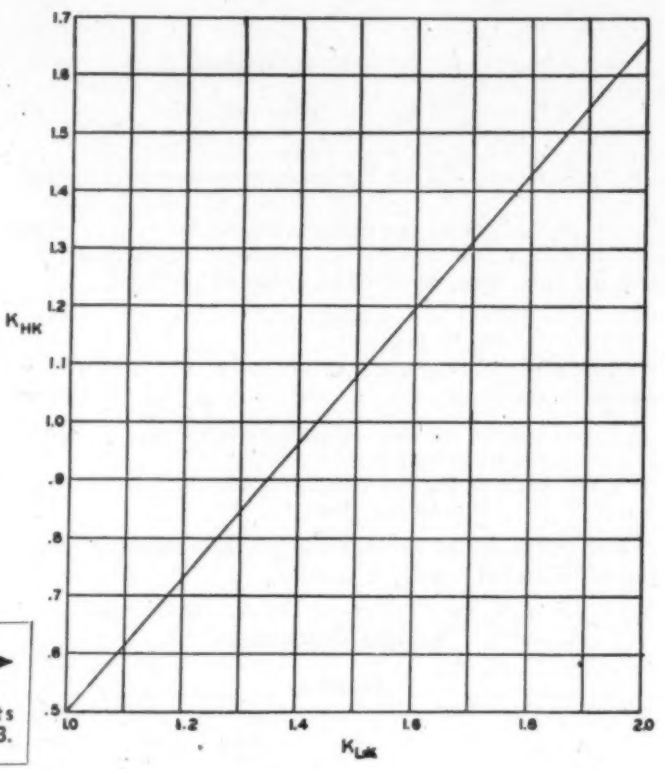

FIGURE 1
Equilibrium Constants for Keys—Problems 1-3.

From equation (4)

$$R_M = 1.28 + \frac{59.2}{40.8}\left[\frac{.16}{\frac{1.86}{.40} - 1} + \frac{.12}{\frac{1.86}{.188} - 1} + \frac{.08}{\frac{1.86}{.092} - 1}\right] + \frac{1.0}{40.8}\left[\frac{1 + \frac{1.35}{3.29}}{\frac{3.29}{.565}}\right]$$

$$R_M = 1.28 + 0.89 + .006 = \underline{\underline{1.38}}$$

It may be noted that the "K" values for the correction terms were taken at the pinch temperatures corresponding to a value $\frac{M_{KD} R'_M}{D} = 1.28$ rather than the true minimum reflux ratio 1.38. However, it should again be emphasized that, had the correction term been large compared to $\frac{M_{KD} R'_M}{D}$, for precise results another calculation would have been necessary, using the first value of R_M (1.38) to determine the "K" values at the pinches.

Discussion and Conclusions

In Table 1 a few results of the present method are compared with results obtained by the Schiebel-Montross[17] and the Colburn[3] methods. The present method shows a maximum deviation of 1 percent from the Colburn[3] method, while that of Schiebel-Montross[17] shows a maximum deviation of 13 percent.

Since the correlation of Colburn[3] holds extremely well for systems of constant volatility and should be equally as reliable for systems in which the volatility varies, no stepwise calculations were made for comparison.

The method presented is as reliable as the correlation of Colburn[3] and requires considerably fewer calculations, especially as the number of components in the system becomes large.

(End of Part I, Parts II and III will appear in an early issue)

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Modern Refinery Instruments—Installation and Maintenance

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THIS paper presents some of the principal factors concerning the installation and maintenance of instruments in the modern oil refinery.

Adequate shop facilities and trained personnel are the primary requisites of an efficient instrument department.

Standardization of instrument installations not only simplifies the training problem but results in increased departmental efficiency and appreciable savings in time and material.

Included in this discussion are a number of shop practices and short cuts that have contributed much toward improved shop efficiency.

This paper was read at the Second National Instrumentation Conference in Chicago, September 8-12, 1947.

RELIABLE instrumentation is now so vital to the successful operation of refinery processes that it is generally recognized that some of our modern units would be non-existent without suitable controls. It is interesting to see instruments in general plant service today that only a few years ago were considered suitable for laboratory use exclusively. This increased tendency toward a more general use of improved instruments is not a desire to "go modern" but is due to fundamental changes in equipment design and a need for closer control of process variables.

Since instruments are now a "must" item in the modern refinery, we have felt the need for an organized and independent instrument department whose function is to specify, install and properly maintain the plant instrumentation. It is the direct responsibility of this group to insure accurate and economical operation of the equipment for which it is responsible.

In an effort to improve departmental and equipment efficiency we have adopted certain standard practices and procedures which have proved beneficial to our group and may be of some interest to other users or prospective users of instruments. It will not be possible to discuss all of the departmental practices and methods of handling the work, so only those of major importance will be mentioned at this time.

One of the most important requirements in the operation of an efficient instrument department is a well equipped shop, centrally located with respect to the operating units. Good illumination for night or day work is very important to a refinery instrument department since it operates on a twenty-four hour schedule. Figure 1 is an interior view of our instrument repair shop. There is excellent natural lighting for day operations, while fluorescent lighting over the work table provides sufficient illumination for the night shift.

The large work table is covered with ⅛-inch steel plate to permit the better handling of heavy equipment such as valves and meters. Lockers in this table and in the work benches along the wall provide the mechanics with space for small tools and personal effects.

One end of the work bench is equipped with two meter test racks and the necessary manometers, air connections, regulating valves and flexible tubing. Both meter racks are provided with drip pans to keep the table top and floor free of mercury.

Safety is an item of primary importance to the instrument department personnel. They are instructed in the safe handling of mercury, inflammable liquids and the servicing of hot oil, light hydrocarbon, caustic and acid meters. Metal safety hats are worn when working in areas where falling objects may cause an injury. Each member is issued a pair of goggles which

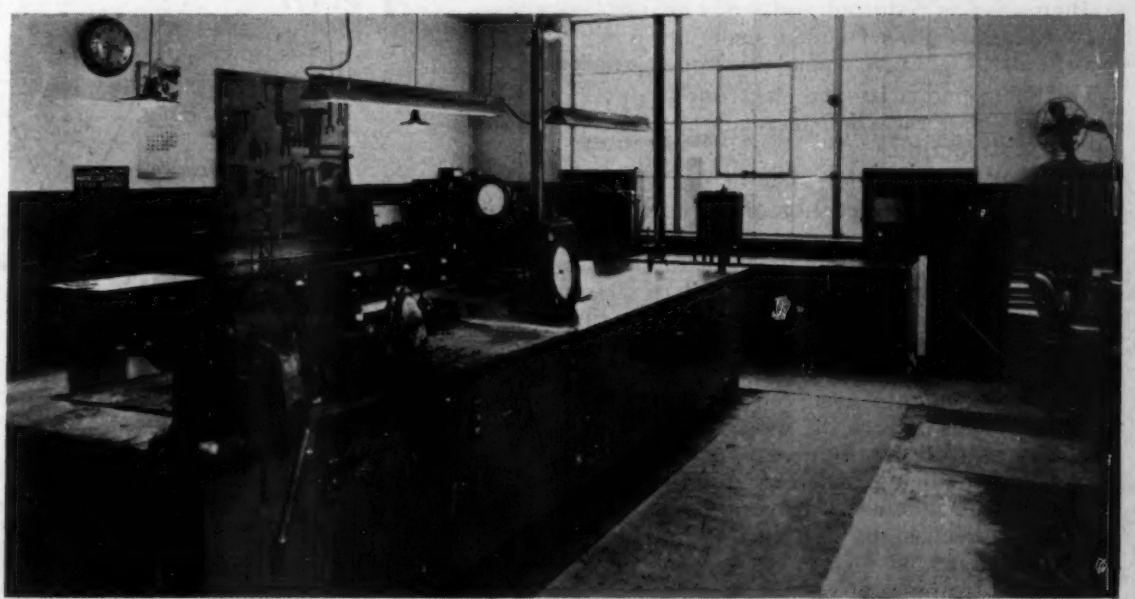

Figure 1. Interior view, instrument repair shop, The Texas Company, Lockport, Ill., works.

Figure 2. Instrument department class instruction room, The Texas Company, Lockport, Ill., works, showing arrangement and equipment.

he keeps available for use when required. Monthly safety gang meetings help maintain interest in the safety program. Many worth-while items come out of these group discussions.

The shop tool locker includes such special items as pneumatic drill motor, for use in hazardous locations, electric drill motor, pneumatic impact wrenches for valve work, saw gun for panel board cutouts, rotary saw for circular cutouts, tubing tools and many other similar items commonly used for instrument installation and maintenance.

In addition to adequate shop facilities the department must have a sufficient number of trained mechanics to do the job efficiently and economically. The trainees are drawn from the general plant forces and must undergo a certain amount of training before they are permitted to service the equipment on the operating units.

Our present method of training instrument mechanics was developed during the war and follows the same pattern set by the War Manpower Commission's program for "Job Training Within Industry."

The training course includes such subjects as elementary physics, basic electricity and electronics, mathematics as required and some elementary chemistry to assist in servicing such equipment as pH recorders, CO_2, O_2, CO and hydrogen analyzers.

The basic electricity and electronics course includes slide films and recorded lectures to supplement the regular instruction.

Figure 2 is an interior view of the training department. Here the trainee not only receives theory or related training but some actual experience on the various types of instruments used in the plant. The equipment is installed on the board to simulate control and may be changed to operate in various ways. The trainees are also taught the use of small tools and are permitted to disassemble and assemble the various instruments assigned to the training room for this purpose. Here the employe receives basic instruction as well as an actual working knowledge of the equipment being used in the plant.

Large scale schematic drawings supplement the instructor's discussions on various instruments and control systems.

The job training program includes approximately one hundred items at this time, and the trainee must qualify in at least 70 percent of these items by written examination and "on the job" work performance tests before he is eligible for upgrading.

The training room also serves as a place for demonstrating new equipment and is frequently used by instrument company representatives in demonstrating their latest improvements or developments.

The standardization of various items and meter piping arrangements has done much toward improving departmental and equipment efficiency. Extra

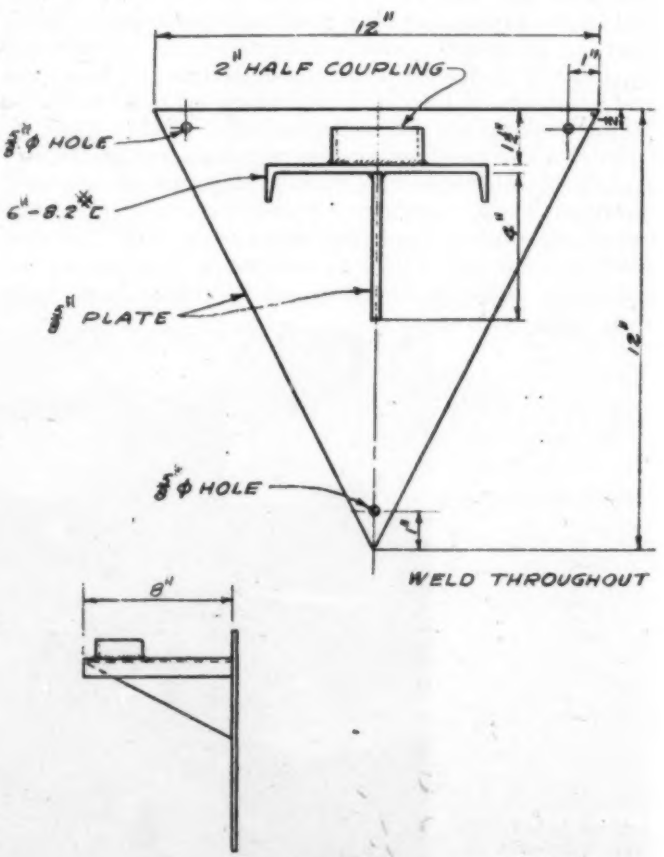

FIGURE 3
Standard Mounting Bracket for Meters.

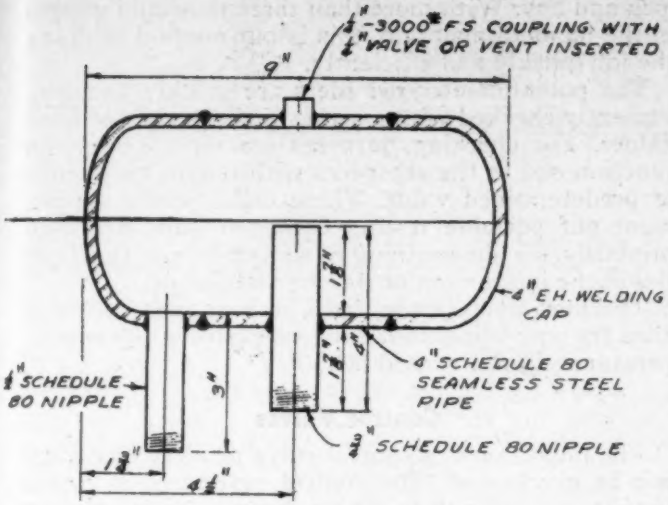

FIGURE 4

Condensing pot steam metering .(Weld throughout as per API-ASME standard. Test pressure 450 psi.)

copies of these standard items and meter hookups are kept on file and are always available to those crafts assigned to do an instrument installation job.

Figure 3 is a standard wall bracket for meters and transmitters. These are kept on hand as stock items and eliminate the past practice of assigning steel men or pipefitters to mount the instrument, using a bracket of their own individual design. The mounting height is a standard 42 inches from the floor to the top of the bracket. This procedure produces a uniform appearance and facilitates planning instrument layouts.

Figure 4 is a special type steam meter condensing chamber especially suitable for low-steam-pressure services.

Figure 5 is a detail of an orifice or pressure tap clean-out device. On connections requiring frequent cleaning these devices are permanently installed as shown.

Figure 6 is a typical meter hookup for hot recycle gas oil using the seal chambers as sediment and water traps. With this type of connection the manometers remain clean for long periods and are unaffected by sediment and water accumulation.

Figure 7 is a typical installation for metering wet gas. There are four-foot risers above the orifice and condensate collectors below the meter.

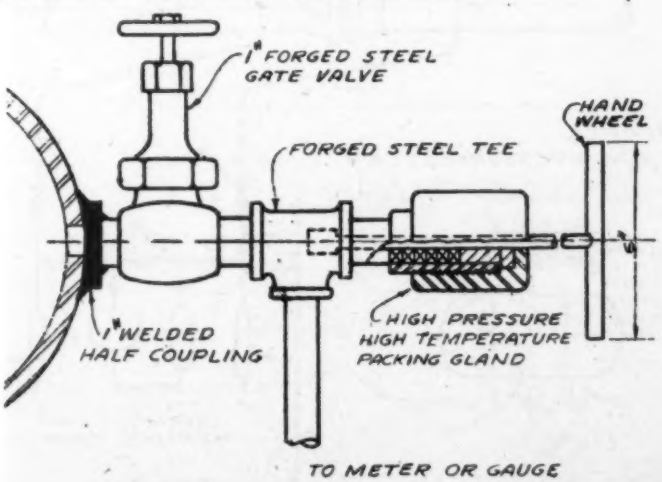
1" FORGED STEEL GATE VALVE
HAND WHEEL
FORGED STEEL TEE
1" WELDED HALF COUPLING
HIGH PRESSURE HIGH TEMPERATURE PACKING GLAND
TO METER OR GAUGE

FIGURE 5

Typical orifice tap cleanout rod or drill. (Note: For flange taps use ½ or ¾-inch connections. Size of tap connection to be determined by flange weight.)

Figure 8 is a recommended hookup for low-pressure steam. The top connected condensers with ¾-inch drain back lines make the installation simple, economical and quite satisfactory for low pressure service.

Numerous types of seals and hookups are used in the flow measurement of caustics and acids. Figure 9 shows one arrangement that has proven quite satisfactory.

Orifice Sections

All orifice sections or primary elements receive special attention from the instrument department personnel. There are a number of special points that must be observed and followed if satisfactory results are to be obtained from this type of metering equipment. These key points follow:

1) Carefully check the length of straight pipe preceding and following the orifice. These distances must conform to ASME requirements.

2) Line must be of uniform bore and free of burrs or roughness. Pipe must extend through flanges so

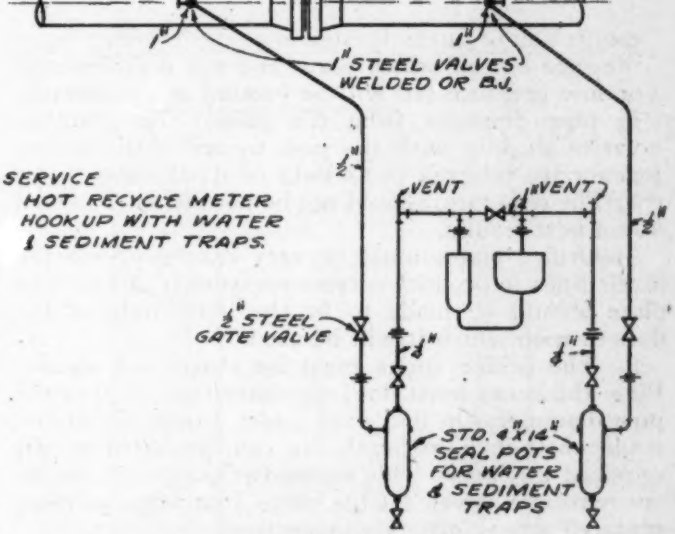
B.J. ORIFICE GASKET
1" STEEL VALVES WELDED OR B.J.
SERVICE HOT RECYCLE METER HOOK UP WITH WATER & SEDIMENT TRAPS.
VENT
VENT
½" STEEL GATE VALVE
STD. 4"X14" SEAL POTS FOR WATER & SEDIMENT TRAPS

FIGURE 6

Hot Recycle Flow Meter.

there will be no recess between the face of the orifice plate and the end of the pipe. If weld neck flanges are used, the inside of the orifice section must be of uniform bore and free of welding burrs or roughness.

3) Orifice taps for liquid measurement are always made on the side of the line or flanges, while taps for gas, air or vapor measurement extend vertically from the line or flanges.

4) The size of the tap may be within the limits of ¼-inch minimum to ¾-inch maximum. Line size and service determines this size.

5) The pressure tap must be absolutely flush with the conduit wall and free of burrs or roughness. Microscopic burrs on the hole edge of an orifice tap have been known to produce errors as high as 4 percent.

6) Location of taps:

a. Flange taps 1-inch up-stream and 1-inch down-stream with respect to the face of the orifice plate.

b. Pipetaps should be located approximately 2½ pipe diameters preceding the plate and 8 pipe diameters following the orifice plate.

c. Vena contracta taps require that the up-stream

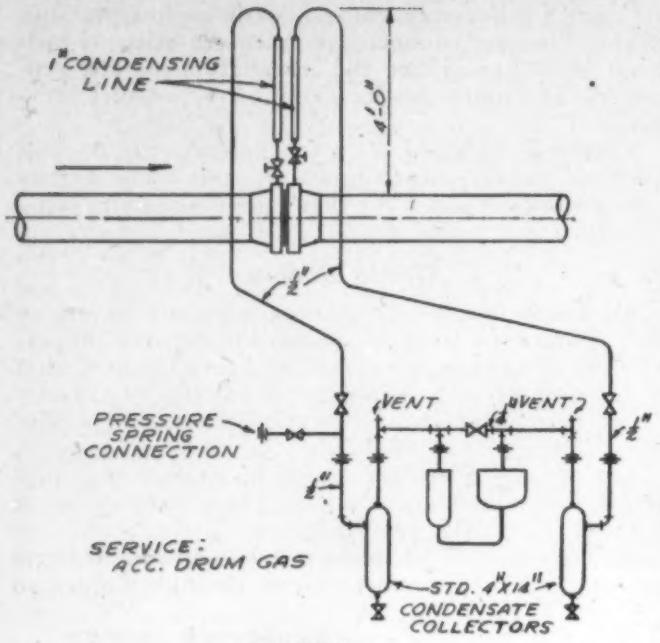

FIGURE 7
Piping for metering wet gas.

connection or tap be located one pipe diameter from the face of the orifice plate and the down-stream or low pressure tap will be located approximately ½ pipe diameter from the plate. This distance varies slightly with the pipe to orifice diameters, generally referred to as Beta or d: D ratio.

7) The d:D ratio should not be permitted to exceed .70 for best results.

8) Orifice plates must be very carefully centered in the lines to produce correct pressure readings. The plate should be made to fit the bolt circle of the flanges with which it will be used.

9) The orifice edges must be sharp and square. Plate thickness must not be greater than 1/30 of the pipe diameter. On line sizes under 4-inch the plates, made of ⅛-inch material, are counter-bored to the required thickness. This method is preferable to the conventional beveled edge plate that was so often replaced wrong after its inspection.

10) The orifice i.d. must be carefully checked during inspection periods and the handle marked to indicate the last calipered size.

11) Connecting lines between the primary element (orifice sections) and the meter, must not be less than ½-inch and they should be graded at least 1-inch per foot to eliminate vapor or condensate traps.

12) In the measurement of light hydrocarbons it is important to locate the orifice section at a point lower than the level of the material flowing from a drum or vessel. Flashing of the more volatile materials occurs when the orifice is installed above the mean liquid level.

All differential type and mercury-less or force balance instruments are calibrated dry using single column well type manometers of various ranges. Low range pressure gauges and pneumatic receivers are carefully checked by comparison with a precision mercury manometer calibrated in pounds and tenths of psi. The dial type standard indicating pressure gauges are checked by comparison with laboratory test gauges. Figure 10 shows our test panel in detail. The four master gauges span the range of 0-3000 psi gauge. The gauges are tested periodically with the dead-weight tester which is ordinarily kept under lock and key. With more than three thousand gauges in the plant to maintain, this is our method of doing the job quickly and efficiently.

The potentiometer recorders are quickly and conveniently checked with a series of check coils of fixed values. For checking purposes we replace the cold junction coil in the recorders with one of these coils of predetermined value. These coils merely supplement our portable testing equipment and are used primarily for determining whether or not the fault lies in the instrument or its external circuit.

Thermocouples made from duplex glass covered wire are now being used quite extensively where temperatures do not exceed 800° F.

Control Valves

The importance of control valve maintenance must not be overlooked. The control system is no better than its control valves. These devices require perfect alignment, correct packing, proper lubrication, a good diaphragm, correct type of inner valve and must be responsive to slight loading air changes on the diaphragm. A trained instrument mechanic should always be assigned to the maintenance of this equipment.

Control valves of large size or those requiring rapid response or amplified air pressure are equipped with air relays or booster pilots.

Pneumatic control equipment must have an adequate supply of clean dry air for trouble free operation. We have made extensive improvements in the instrument air system to provide a satisfactory air supply. Each operating unit is equipped with air scrubbing equipment and auxiliary air compressors to take over in case of plant air failure. These compressors "float" on the air line and cut in at a predetermined minimum air pressure.

Figure 11 is a schematic diagram of an inexpensive and efficient air cleaning system. This cleaner when constructed of 12-inch diameter pipe and each tank approximately six feet in height will handle the air

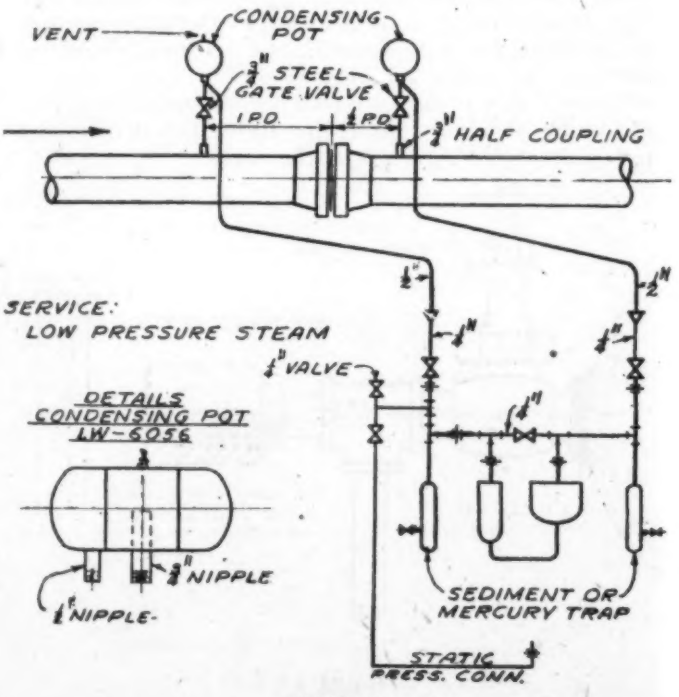

FIGURE 8
Low-pressure steam meter. (Note: Both condensers must be level and level with each other.)

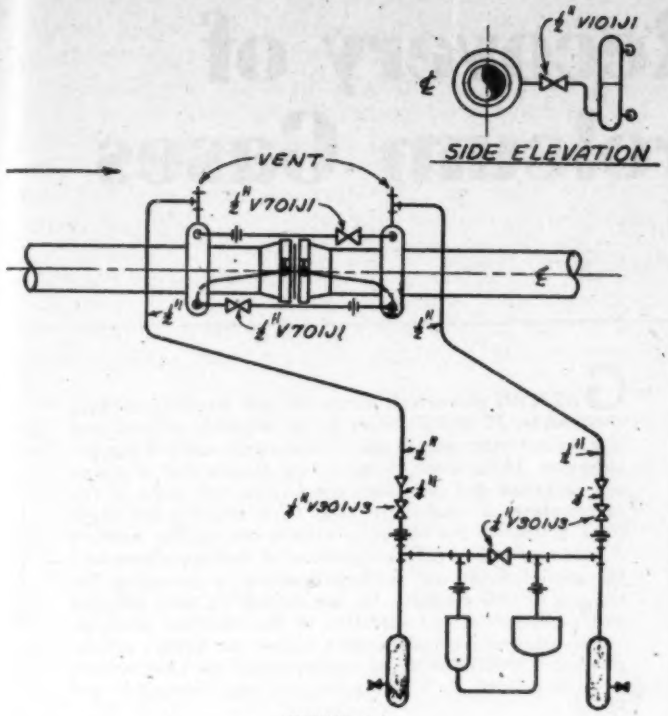

FIGURE 9
Caustic or acids meter.

for approximately 20 control instruments. The refractory bed in the bubble tank is made up of Raschig rings, the bubble tank liquid is transformer oil. The units are cleaned every six months. There are various types of small air cleaning units now available for this type of service, and these units will be used on new construction.

All steam generators in the boiler house are equipped with automatic controls primarily to insure maximum fuel economy but also to maintain constant steam pressure. The control system is designed to burn either gas or oil separately or in combination and in any ratio. The steam pressure is held within very close limits in spite of the fact that waste heat boilers of varying output on other units in the plant also feed into the plant steam system. Without control on the boilers it would be a very difficult problem to maintain constant steam main pressures. The advantages of controlled steam pressures are reflected in fuel saving, better pump and turbine operations and improved process control.

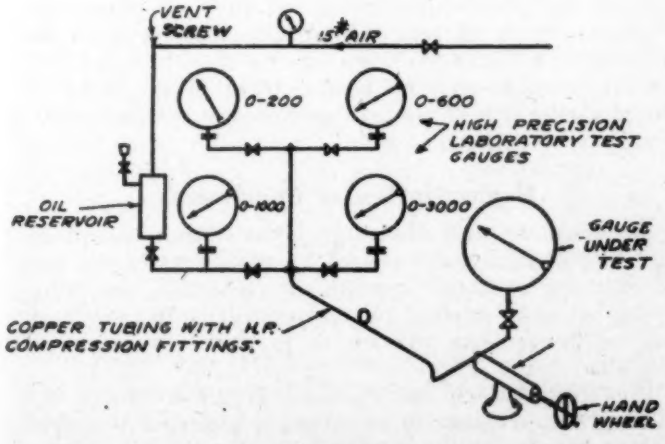

FIGURE 10
Testing panel for indicating and recording pressure gauges. (Note: All valves are steel needle valves, all fittings and valves are back welded.)

One unique feature of this control system is the use of a specially designed air relay to permit the operation of two different control systems on one master controller. The air relay has a ratio of approximately 1 to 10.

Another interesting feature of this control system is the safety arrangement that prevents the introduction of more fuel into the furnace than there is air available for burning it. This safety system within the control scheme measures fuel quantities and balances them against air flow quantity in a totalizer which cuts back fuel loading pressure and increases loading pressure to the air flow controller.

Among the numerous special items worthy of mention are the pH recorders and controllers, gas analyzing equipment and the Penetron.

The determination and control of pH is important wherever water or water solutions are used. The modern refinery is continually discovering new benefits and new economies through the utilization of pH instruments. The instrument men are instructed in the servicing of this equipment. A daily check of this equipment is required, and at this time the cells are carefully checked with a buffer solution that is verified by the plant laboratory technicians.

The Penetron is an instrument developed by The

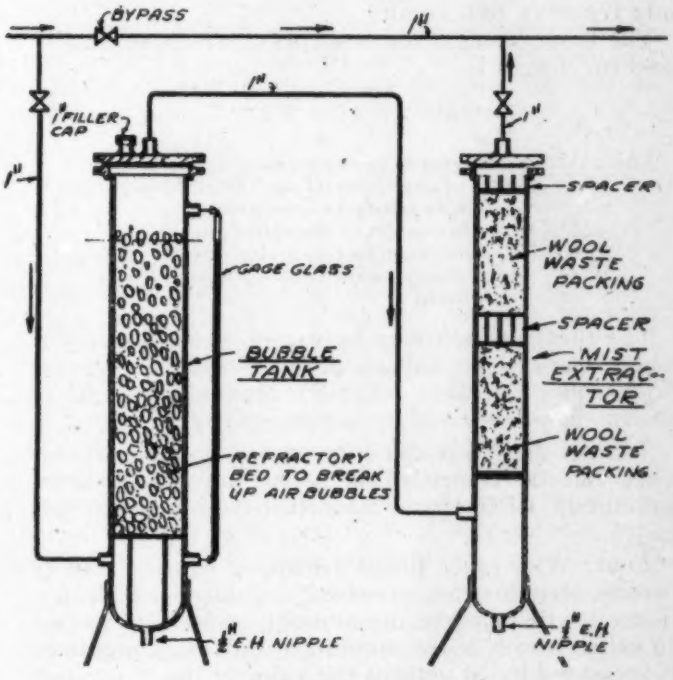

FIGURE 11
Piping diagram of instrument air-cleaning unit.

Texas Company and used in the refinery for the determination of wall thickness of lines, vessels and tanks. It accomplishes this function with a high degree of accuracy by the use of penetrating gamma rays. Calibration checks on the operation of the instrument are made periodically in the shop as a routine service practice.

Conclusion

It has not been possible to mention all of the worthwhile practices and operating methods used in our instrument department, but it is hoped that those presented may contribute something toward the improvement or solution of some of your own instrumentation problems.

Maximum Recovery of Liquefied Petroleum Gases

J. A. CRAIG
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GASOLINE plants built during the past several years were designed for 75 to 95 percent of the available propane and 100 percent extraction of the heavier components in the gas processed. These plants, however, are complicated in design and operation and cost many times more than some of the earlier plants of comparative size. Their design is not applicable to that of the earlier or existing plants. The author's discussion pertains to the operation of existing plants and the considerations and methods involved in increasing the recovery of LPG products. He has divided his topic into two parts—absorption, and retention of the absorbed products.

The prepared discussion which follows the Craig's article, contains additional material and comments on LPG recovery in existing plants by B. O. Bentley, of Hagy, Harrington and Marsh.

These presentations were before the first Panhandle Regional Meeting of the Natural Gasoline Association of America, December 12, Amarillo, Texas.

EMPHASIZED here will be the operation of typical existing equipment rather than the engineering design of plants which might be built to extract high percentages of propane and butane. It is not unusual for plants to be designed and built which are capable of recovering 75 to 95 percent of the available propane and all of the heavier components in a processed gas. However, such design is, as a rule, elaborate and expensive and so is not generally applicable to existing plants which were designed essentially for the recovery of natural gasoline.

The subject will be divided into two parts, 1) the absorption of LPG, and 2) the retention of absorbed LPG. Each of these divisions is of equal importance, since ultimate recovery in the stock sales tank is the only recovery that counts.

The basic formula for absorption which is usually used for design is:

$$A = \frac{3.156\,dG}{KM}$$

Where D = specific gravity of absorption oil
G = gallons of absorption oil per 1000 cubic feet of gas
K = Equilibrium constant of component
M = Molecular weight of absorption oil
A is the absorption factor varying directly with the percentage absorbed of the component being considered.

The things which may be varied in the above formula then are 1) Gallons of oil circulated *(G)*; 2) Equilibrium constants *(K)*; 3) Molecular weight of absorption oil *(M)* and its specific gravity *(D)*.

Taking these variables up in order, one may see what can be controlled in order that a maximum amount of LPG can be absorbed from a given raw gas.

First: With other things remaining equal, it can be readily seen that an increased circulation of absorption oil will increase the amount of LPG absorbed. In other words, if the amount of oil being circulated is increased by 50 percent the value of the absorption factor will likewise be increased by 50 percent, provided the other variables remain the same, which will be true if the same quality of absorption oil is used at the same temperature and pressure.

The Equilibrium Constant

Second: We should then look into the symbol *K* which designates the equilibrium constant and see wherein the value of this factor varies. The value of *K* for any given hydrocarbon component of a gas varies with the temperature and pressure at which this gas is being processed. Since *K* appears in the denominator of the equation, it is apparent that the absorption factor increases in value as the value of *K* decreases, so we need to know what causes the *K* value of a component to decrease. The *K* value of a given hydrocarbon decreases with a decrease of temperature and with an increase of pressure. For example, the *K* value of propane at 100°F. and 50 pounds psia is approximately 3.2; while at 45°F. and 50 pounds is approximately 1.6. This means that if the rich oil temperature in the base of an absorber operating at 50 pounds could be decreased from 100°F. to 45°F., the absorption factor of propane could be increased to twice its original value. To illustrate the effect of pressure on the absorption of propane, let us assume that the pressure of an absorber could be increased from 50 pounds to 70 pounds with the rich oil temperature remaining constant at 100°F. The *K* value of propane at 50 pounds absorption and 100°F. is approximately 3.2, while at 70 pounds absorption and 100°F. it is approximately 2.3, or a decrease of .9 of a point in value. Here again, the absorption factor would be increased this time by the ratio of $\frac{3.2}{2.3}$ or 139 percent of its original value.

In actual plant operation the above examples are likely exaggerated, since such drastic effect could hardly be attained without substantial change in design of the plant considered, but they do point out the importance of maintaining the highest possible economic and safe pressure on the absorber and the lowest possible rich oil temperature in the base of the absorber if high percentages of propane or butane are to be absorbed.

Neglect in Use of Equipment

A complete and thorough examination of plant operation will usually reveal some neglect in the use of existing available equipment, which is resulting in higher than desired oil temperatures and in varying or lower than maximum practical pressure on the absorber.

Anything which can be done either to lower the rich oil temperature or to raise the absorber pressure will certainly result in an increase in the amount of LPG absorbed and in most cases some means of lowering the oil temperature or increasing the ab-

sorption pressure can be found which will cost nothing except a little by the plant operator.

Pre-cooling of the lean oil going to an absorber to a temperature lower than existing operating temperatures often may be attained by relatively small expenditure being made for more cooling equipment—more efficient cooling equipment, or more efficient use of existing equipment. The use of a refrigerant for cooling medium in place of or as a supplement for water is commonly used to allow cooling of the absorption oil to a lower temperature. Discussion of this problem could easily become very involved and actually it is a problem to be analyzed in each plant.

The use of inter-coolers on the partly saturated absorption oil often offers a comparatively cheap and efficient way of reducing the rich oil temperature in the base of the absorber. This is true because the oil, as it absorbs components of a raw gas increases in temperature due to the heat of absorption, and may be rather simply reduced to a temperature as low as the original lean oil temperature by the use of cooling mediums already at hand.

Increasing Pressure of Absorber

The problem of increasing the pressure of the absorber can often be solved without the use of more horse-power, by removing "bottle-necks" in the piping system or control system, or by the use of properly sized clearance pockets on existing compressor cylinders which will unload the compressor units under conditions which currently exist but which were not anticipated in the original plant design. If additional horse-power is required for the increase of absorber pressure, each case must be carefully weighed to be sure that the cost of this increased operating horse-power does not exceed the value of increased products. A summary of this entire section can be made by reminding ourselves that the truly valuable plant operator is the one who can get that extra degree or two of cooling or that extra pound or two of pressure out of existing equipment. We have all known a few of these outstanding operators who, as a result of knowledge and industry, always get those extra few hundred gallons of production "for free."

The third and fourth variables in our absorption equation are necessarily dependent one on the other and so must be considered together. As the molecular weight of an oil goes down, the specific gravity also goes down, but not in direct proportion. An advantage can be gained by carefully selecting the type of absorption oil to be used. Oils are available on the market which have a low molecular weight which will result in an increase in the value of the absorption factor in our formula. The use of very light absorption oils sometimes causes problems in the distillation unit of a plant, which outweighs the advantage to be gained in the absorber. This is often true because existing stills and appurtenant equipment were not designed for the close fractionation required for efficient separation between the light absorption oil and the natural gasoline components.

It is true, however, that many plants are using an "old-fashioned" absorption oil which is heavier than necessary, and which has a light molecular weight resulting in a low absorption factor. If this is the case in any given plant, valuable LPG components are being lost which could be recovered by the purchase and use of a carefully selected "modern" absorption oil.

If everything possible is done to absorb the maximum amount of LPG components from raw gas, then a big step has been taken toward recovering valuable products which might otherwise be wasted, but even then one is only half-way through the fight to get these products into sales tanks. This is true because there has been picked up in the absorbers a certain amount of undesirables. These villains are ethane or methane, and have the usual villainous characteristic of not wanting to be eliminated from society without taking along some good citizens.

Not many years ago, propane and butane were villains which caused us to lose some of our "good citizen" components of natural gasoline. In order to eliminate propane and butane from natural gasoline without excessive waste, our engineers developed stabilizers. These stabilizers served their purpose very well and allowed the sale of stabilized natural gasoline, which could be used for blending purposes without excessive evaporation losses. Since the overhead product from these stabilizers had to be condensed for reflux purposes, it was a natural step for conservation-minded people to want to sell this condensed liquid and as a result the LPG market was developed. As this market developed the old fashioned stabilizer was found to be inadequate for efficient recovery and separation of LPG products and complete efficient fractionation facilities became an important part of most gasoline plants.

Ethane and Methane Problem

At this point the discussion is ahead of the flow of absorbed products, since it was left in the absorption oil and it hasn't been taken through the stills which are necessary before fractionation. Here is where ethane and methane give the most trouble, for here our raw product is released from the dampening effect on its vapor pressure exerted by the very stable absorption oil, and yet is limited to low condensing pressures, since most plants can not reach still temperatures necessary for stripping of the oil at pressures exceeding some 60 psi. These are conditions under which ethane and methane become most uncontrollable and in vaporizing take with them a percentage of valuable LPG products.

If rich oil is flashed at lower than absorber pressure before it is introduced into the still, a certain amount of methane and ethane can be eliminated without excessive loss of LPG products. This is true because low-pressure flashing is selective to a great extent, i.e., a greater percentage of the aborbed lighter components will be flashed under low pressure than will the heavier components.

In order that the flashing procedure may be successful in eliminating the undesirables and in not losing too much of the wanted products, it is often necessary that a re-absorber, or rich oil fractionator be used with a "reflux" of lean absorption oil. In many plants, however, no such equipment is available, so ordinary rich oil tank venting or flashing must be used, with the flash vapors usually going back for recycle with the raw gas. A complete engineering survey of any particular plant is necessary accurately to set the ideal flash condition for the rich oil in that plant. It is generally true, however, that if a great deal of noncondensables are being vented off of the

re-compressor make tank or off of the still make tank, a saving in recovered LPG may be made by reducing the pressure on the rich oil vent tank. It is at least a possibility worth experimenting with.

Another Problem

After as much of the undesirable villains as is practical have been eliminated before introduction into the still, the problem of condensing all possible vapors for their transmission to the fractionator is faced. Here again, that extra degree or two of cooling and extra pound or two of pressure becomes important. Here, again, is where it becomes so vital to be sure that existing equipment is being used to the fullest.

After everything has been done to condense all possible products in our make tanks, a considerable amount of non-condensable vapors will come off of these tanks if there has been absorbed any considerable percentage of the LPG available in the raw gas.

In nearly all plants a recompressor is used to compress these vapors to as high as is practical pressure for condensation, thus saving much of the desirable products. Here a relatively small investment often can be made which will reduce the amount of LPG waste. If the make tank gasoline is pumped in with the recompressor discharge steam and allowed thoroughly to mix, there results the ultimate effect of high pressure condensation of the total product. This means the same result as a high-pressure still without having to worry about temperatures necessary for stripping in a high-pressure still. Since the fractionator usually operates at fairly high pressure, the work done in pumping the make tank gasoline to a higher pressure is not wasted. In a typical plant being revamped, the use of this means of high-pressure condensation shows to mean the recovery of some 1350 gallons per day of salable product (essentially propane and butane) without changing the pressure on the discharge of the recompressor.

A means of reducing the vapor pressure of the still make tank product and so reducing the waste has been successfully used with the mixing of stabilized gasoline and the still overhead product, and so increasing the percentage of heavier products in the gasoline going into the make tank. This process is covered by a patent No. 2,184,596 and details on it are available from that source. The advantage of this combination of the heavier and more stable gasoline with the un-stable still make is rather apparent. Thorough mixing of the two streams is of paramount importance.

Fractionators

Since the elimination of ethane and methane is the first thing desired in the fractionator, it is usually best, where possible, to de-ethanize in the first fractionator that processes the gasoline. If the villains can be eliminated there they will cause no further worry and the problems of condensing them will not occur to complicate later fractionation cuts. Many plants are equipped to do this de-ethanizing job in the first tower, since high-pressure equipment and often refrigeration of the overhead is necessary. If this equipment is not available, the importance of the lowest practical condensing temperature and the highest practical condensing pressure again is emphasized. Here again that extra degree or two of cooling and extra pound or two of pressure are important. There is a tendency for over reflux of a fractionator. This is often done in order that to be sure that the product is on the safe side of quality, and since such safety is desirable to a reasonable extent, it should not be discouraged. However, a greatly excessive reflux ratio tends to overload the cooling system and overhead piping system with resultant poor final cooling and lower than ultimate condensing pressure. Since these two results are undesirable, it is good practice to watch closely for unnecessarily high reflux rates.

In order to be able to assure customers of a quality product, proper fractionating equipment, together with its appurtenances, such as treaters, dehydrators, sufficient storage, etc., is of paramount importance. It is a crime to go to all of the trouble to absorb, hold and fractionate a quantity of LPG only to find that it is of a poor quality because of the lack of a few control instruments, or for the lack of prudence in the use of available equipment.

Discussion of

"Maximum Recovery of LPG"

B. O. BENTLEY,
Hagy, Harrington and Marsh, White Deer, Texas

MR. CRAIG's methods of extraction and retention are sound and proven practices.

While we all strive to increase the degree of butane and propane recovery, a number of us are limited by gas sales contracts governing the Btu or heating value of the residue gas leaving the plant. If we lower the Btu value of the gas below the stipulated figure then we are working against ourselves and suffer a greater loss of value than the worth of the extra quantity of these liquid products produced.

Generally speaking this will not be a stumbling block, with the existing equipment, but it is not practical and efficient to strip below these Btu limitations.

Most of our plants were originally designed for the extraction of 26:70 gasoline. Natural gasoline prices were more or less fluid, and management, seeing the possibility of the ever increasing demand for butane and propane, has in most instances, modified these existing plants for extracting additional quantities of these products. This program in many instances has secured existent investments in gasoline plants.

Since oil absorption plants are used almost entirely for extraction, oil rates have been increased and additional absorbers installed to increase recovery of liquefied gases. In some instances higher API gravity oil has been employed to give greater recovery.

From a practical standpoint for every degree API gravity oil recoveries are increased by approximately 2 percent. This has some advantages, more especially if you are circulating a maximum oil rate to begin

with, and it is a sure thing you have increased the butane and propane extraction by a large percent.

Recovery Means Needed

As you go through the primary flash tank to free the oil stream of part of the undesirable vapors, namely ethane and methane, it is necessary to establish some given operating pressure. This from a practicable standpoint can be operated as low as ½ of the absorber pressure without seriously flashing too much of the desirable hydrocarbons. This oil in turn can be flashed through a secondary flash tank again lowering the pressure by 50 percent. These vapors are too rich in butane and propane content to be wasted. it is necessary to adopt some means of recovery, either by recompression or preferably a reabsorber with a high oil rate. If a high oil rate is used it would not be practical to strip this oil, because of the possibility of overloading the stills. It could be pumped into the denuded oil stream before going to the cooling coils for final cooling. This partly saturated oil will have good effect in keeping the rich oil at a minimum temperature leaving the absorber.

Practical Rule Cited

The importance of cooling has been stressed by Mr. Craig. Another of the practical rules of operation, as we might term it, is for each degree the oil temperature is lowered is equivalent to approximately 2 percent increase in oil rate. This is another big factor in obtaining efficiency; this alone will justify a sizeable expenditure to obtain a minimum oil temperature.

In some plants propane refrigeration further to cool the absorption oil has been installed with wonderful results. Sixty-five to 70-degree oil for summer time operation may sound like a dream but it can be made a reality.

During the revamping and modernization to further the extractions of the lighter ends, we should keep in mind one of the vital phases of operation which is constant smooth operation, free from fluxuations.

This can be costly in valuable vapors, that will be entrained with the undesirable ones. For example, an absorber doesn't give any trouble other than a tendency to vary 4 to 6 inches. This fluxuation will be carried through the entire gathering system on through the compressor system, each place where there is some vessel working under a back pressure. This will flash a far greater amount of the desirable vapors than is necessary. The result will be that old Army game of buck passing. That is what happens when the production comes up short. The operator usually hears the sad news and he is to be highly complimented for shouldering the burden of operation and making that extra gallon, so the management can smile instead of frown.

To make and recompressor mixed streams entering the recompressor accumulators tank can be cooled several degrees during the summer months when it is a struggle to maintain propane and butane production—when the wet bulb temperature is usually high and the cooling tower is pressed for lack of breeze. Sometime it is profitable to resort to some other method of cooling. We are dependent upon water wells for the plant water supply. The temperature of this water will run from 60 to 63 degrees. It is only practical and sensible that we should utilize this free means of cooling by installing some closed type cooler in our make and recompressor lines, after they leave the cooling tower. The plant make up water is usually pumped to some tank for further treating and distribution. There is no further cost of circulating it through the intercooler realizing the benefit of several additional degrees cooling which is a vital factor in propane and butane retention.

Problem of Fractionation

After we have utilized all of the available equipment and resources to further our production of LPG we have another problem—fractionation. If the first column is a de-ethanizer then it certainly is of prime importance that an operator should exercise his ability to get the proper and maximum fractionating efficiency from this column. It is possible to cut very deep into one's much needed propane and still look like you have good column operation.

The de-ethanizer should be under constant observation.

The stock tanks are ultimate tattletales of your operating efficiency. They should not be forgotten and allowed to pop or leak valuable vapors. If they are low-pressure vessels, you may prevent the loss of vapors by manifolding them together. This, in some instances, is a conservation measure.

Most plants in this area dispose of the products by tank truck. This method will introduce undue waste in products being loaded, unless there is some method provided to conserve these products which are so readily vaporized. A series of vapor return lines to the source of loading tanks will tend to conserve these elusive vapors.

Significance of Fuel Sensitivity in The Performance of Motor Gasolines

E. J. McLAUGHLIN and J. A. MILLER
California Research Corporation, Richmond

THE term fuel sensitivity is one which is generally used to define the change in the antiknock value of a gasoline as a function of the severity of the operating conditions used. For example, a comparison of the change in octane number of several fuels in a given engine as the inlet air temperature is varied would be one means of determining the sensitivity of the fuels. Any operating variable, such as engine speed, compression ratio, or spark advance could be used, either independently or combined, to vary the severity of the test method. The operating variables used to change severity are usually those which most nearly duplicate the service conditions related to the problem being studied.

Applying the term fuel sensitivity to motor gasolines, a variety of techniques can, and in some instances are, employed to determine how the fuel performance changes with a change in severity of one or more operating conditions. However, the fuel sensitivity of motor gasolines is usually evaluated by two well-known test methods, the F-1 or research method and the F-2 or motor method. These methods are basically similar (both conducted in a single cylinder CFR engine) and consist of bracketing, at a constant knock intensity, the unknown test sample with reference blends of a given octane number, thereby permitting interpolation which enables the operator to assign an octane number to the unknown fuel. However, the operating conditions used for the two tests differ considerably, the most significant conditions for each of the methods being shown in the following table.

CONDITION	TEST METHOD	
	F-1 (Research Method)	F-2 (Motor Method)
Inlet Air Temp., °F.	125	75-125
Mixture, Temp., °F.	.....	300
Spark Advance, °BTDC.	13	Variable—19 to 26
Engine Speed, rpm.	600	900

The above comparison shows that most operating conditions are less severe for the F-1 method than they are for the F-2 method. Thus the F-1 method almost invariably permits a somewhat higher compression pressure and power output than the F-2 method for a given degree of knock on any one fuel. However, since the test fuels are always compared with reference fuels and evaluated in terms of octane number, it is not the absolute change in power output or performance which is considered, but rather the change relative to the standard reference fuels. Thus, a fuel which changes in antiknock performance to the same degree as the reference fuels will have the same rating or octane number as the reference fuels and is considered to have zero sensitivity. On the other hand, a stock which is more sensitive to test severity than the reference fuels will have an appreciably higher rating or octane number under the milder or F-1 test conditions than it will under the more severe F-2 conditions. In motor fuel test terminology, it is the generally accepted practice to denote the sensitivity of any fuel by the amount that its octane number is changed by the F-1 and F-2 test methods, or mathematically, sensitivity of a motor gasoline is equal to the difference between the F-1 and F-2 octane numbers of the fuel.

For those not familiar with this system of evaluating fuel sensitivity, an indication of typical sensitivities for several basic stock types may be of interest. Straight-run, highly paraffinic gasolines, because of their similarity to the reference fuels, usually have a difference in rating by the two test methods of zero to two octane numbers and are therefore considered to have low sensitivity. In the case of cracked or reformed gasolines, the sensitivity is normally a function of that percentage of unsaturated materials present, the more highly cracked stocks having fuel sensitivities as high as 10 or 12 octane numbers. Stock containing appreciable concentrations of aromatics also usually have reasonably high sensitivities, the exact magnitude depending upon the amount and type of aromatic present.

THE authors have here an excellent discussion on the significance of sensitivity in the performance of motor gasolines. If the octane number of the gasoline is too low, they point out, an optimum sensitivity does exist for each vehicle to permit a uniform degree of freedom from knocking, or a constant knock intensity under most full throttle operating conditions. Also, an engine will knock under certain combinations of speed and load at full throttle, if the fuel has a sensitivity appreciably different from that required for knock-free operation. If the octane requirements of the engine are reduced by spark retardation, the result is less power and economy, quicker deposit buildup, and probably overheating.

Presentation originally was before the California Natural Gasoline Association meeting in Los Angeles in October.

Importance of Fuel Sensitivity to Road Performance

The public has been taught that knocking can be prevented by using a fuel of the required octane number, or if knocking does occur it can be eliminated by a fuel with a rating higher than that normally used. Recent research has indicated that within certain limits the same can usually be said of fuel sensitivity; i.e., knocking can, in many instances, be eliminated by a more sensitive fuel of the same F-2 octane number. This conclusion is the result of road tests conducted to determine why fuels of the same F-2 octane number did not provide the same degree of freedom from knock. It was found that if the test fuels had the same F-1 rating as well as an equivalent F-2 rating their road performances were usually equal. Furthermore, it was found that the sensitive fuels performed best at low speeds and the insensitive fuels best at high speeds. For most vehicles in proper mechanical condition and with a normal amount of combustion chamber deposits, the F-1 rating of the fuel will usually be close to the road rating or road octane number obtained when the car is operated under full throttle conditions at speeds of 20 to 25 miles per hour. Conversely, the road octane number of any test fuel will usually approach the F-2 rating of the fuel under full throttle conditions at engine and road speeds of 60 to 65 miles per hour. Figure 1 shows road octane number as a function of car speed for four fuels of different sensitivities, all of them having an F-2 octane number of 74. The zero sensitivity fuel; i.e., the one which is 74 by both of the laboratory test methods shows the same road octane number at all speeds. The other three fuels, having laboratory sensitivities or differences between F-1 and F-2 ratings of 4, 8 and 12 octane numbers, respectively, provide successively higher road octane numbers in the low speed range and all have the same road rating of 74 octane (which is the same as the F-2 rating of the fuel) at approximately 58 miles per hour. Also, it may be noted that at 30 miles per hour the road rating of all of the fuels is within one or two octane numbers of the F-1 laboratory rating.

It is frequently difficult to obtain a clear concept of the effect of fuel sensitivity on road performance based on a comparison of road octane numbers because road octane numbers do not show the absolute effect of fuel composition on the knocking tendency of the engine-fuel combination; but rather they show the effect of the fuel composition on the tendency to knock relative to the knocking tendency of some reference stock. It may therefore be of interest to study a set of curves actually obtained on the road with a test car showing the variation in the amount of knock obtained with fuels of different sensitivities as the car is being accelerated on the level road. Figure 2 is a chart showing the variation in knock intensity of three zero sensitivity reference fuels (68, 70 and 72 octane numbers) and one 70 octane commercial type fuel having a sensitivity of 7 octane numbers as a function of car speed. This chart clearly demonstrates the marked low speed superiority of a sensitive fuel.

The road antiknock value of a fuel could be measured by obtaining curves of audible knock as a function of car speed, but most trained observers prefer to use the "borderline" type of test for determining road octane numbers because greater precision can usually be obtained. This greater precision results from the fact that with the "borderline" test the observer records the speed at which the knock commences and the speed at which it dies out with a fixed spark setting which is considerably easier to do than to attempt to estimate the intensity of the audible knock at certain specified speeds while a car is accelerating along a level road or climbing a hill. However, the same type of data may be obtained from either of the two methods and the "borderline" test procedure is mentioned here only because it is the technique generally used in road testing. Using the "borderline" technique has no major effect on the road octane numbers obtained or the conclusions which may be drawn from such road octane numbers.

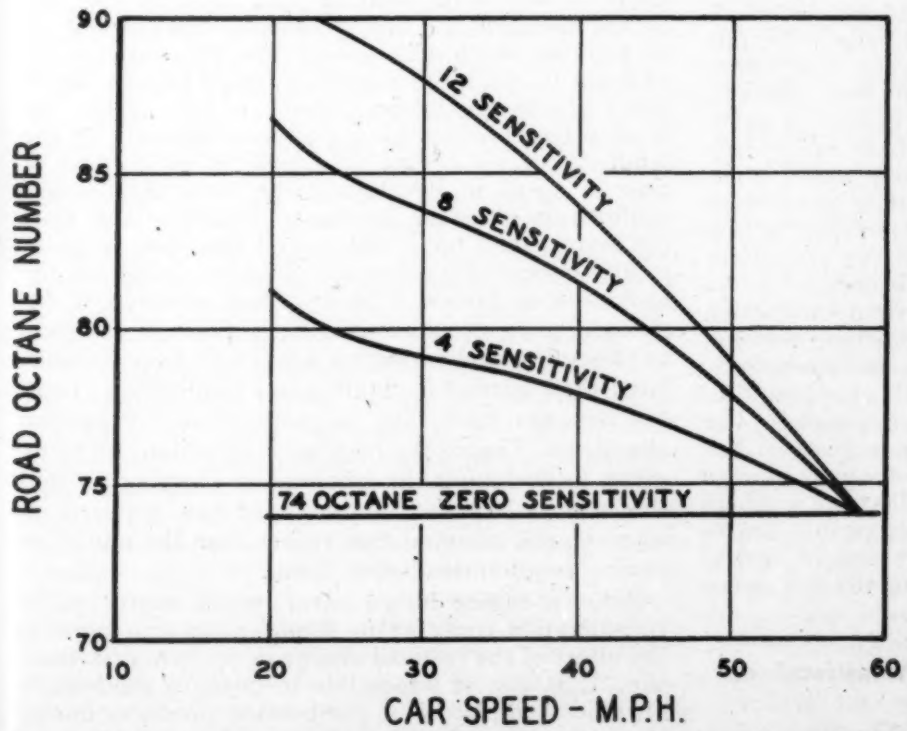

Figure 1. Effect of Sensitivity on Road Octane Number. (74 F-2 octane number; 0, 4, 8, 12 sensitivity. Test car A).

Comparison of Fuel Performance

Establishing the road performance of several fuels is a very difficult procedure because of the great variation between different cars, even those of the same make and year model. Figure 3 shows the road octane ratings of four fuels having the same F-2 rating and sensitivities of 0, 4, 8, and 12 octane numbers, respectively, as obtained in three different makes of test cars. On this chart the results from the car which shows the greatest response to sensitivity are presented at the top, the next most responsive are shown in the middle and the vehicle showing the least improvement with sensitivity are shown at the

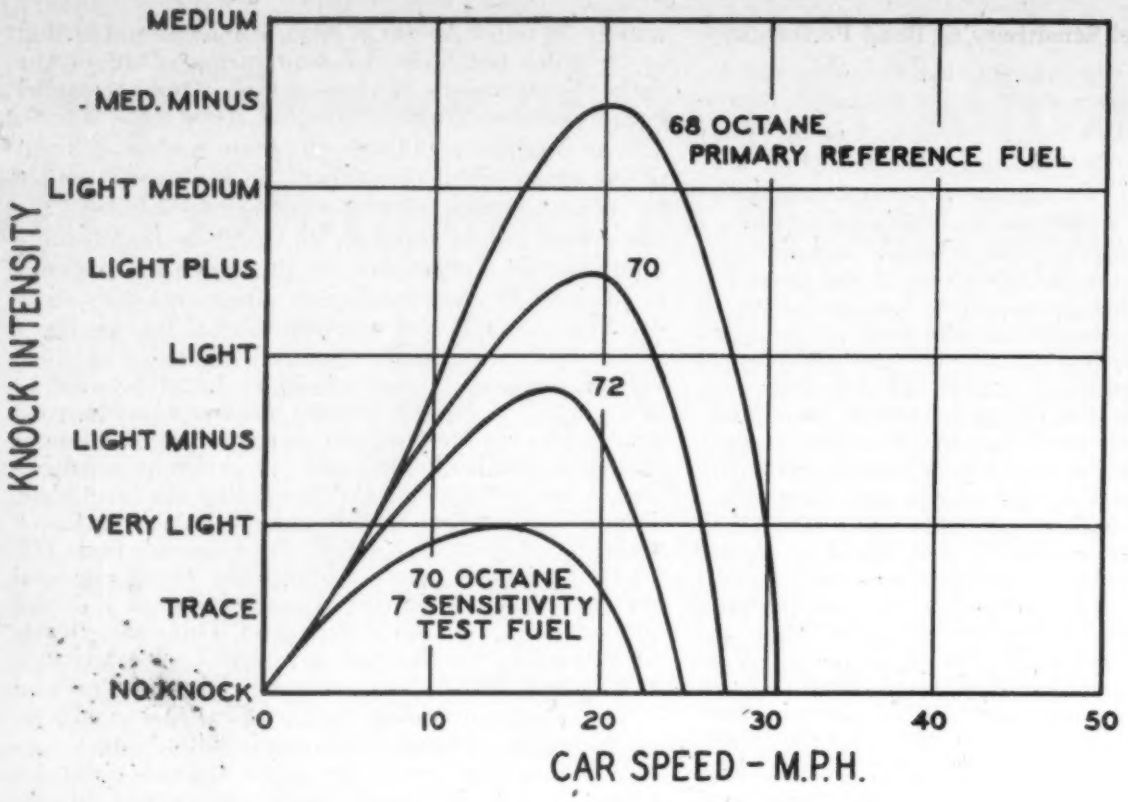

Figure 2. Variation in Knock Intensity with Octane Number and Sensitivity. (Level road, full throttle acceleration, Test car D).

bottom. It may be noted that even the third test car which showed the least response to sensitive fuels still gave markedly improved octane numbers at low speeds as compared to the zero sensitivity test fuel.

Relative Importance of Knock-Free Performance

It is the mutual desire of the car manufacturer and the fuel refiner to supply an engine-fuel combination which will provide essentially knock-free operation at all speeds and loads. Ideally, optimum efficiency in this regard would be achieved if a fuel was just satisfactory (i.e., gave incipient knock) under all full throttle operating conditions. Unfortunately, this cannot be achieved because of the very wide variation in the fuel requirements of different vehicles. Furthermore, a great sacrifice in the quality or quantity of fuel would have to be made if the refiners attempted to market a gasoline which would completely satisfy the most critical engines under their most severe operating conditions. Therefore, the best compromise appears to be to match the sensitivity of the fuel to the sensitivity requirements of the average vehicle. This means that certain cars which have an abnormally high low speed octane requirement will encounter low speed knock and conversely, those having an unusually high speed octane requirement will encounter detonation at high speeds. The fact that all operators operate their engines at full throttle at low speeds much more frequently than they do at high speeds, and the fact that the windage at high speeds is so great that a reasonable degree of detonation cannot be detected results in careful consideration being given to meeting the low speed requirement.

Effect of Engine Design and Adjustment on Fuel Requirement

The engine designer has to make many compromises in developing an engine which will be satisfactory from all standpoints. Many of these compromises have a direct bearing on the octane requirement of the engine. Some of the features which affect the final octane requirement are obvious, such as the compression ratio and the amount of mixture heating provided in the intake manifold to insure satisfactory operation at low temperatures. Thus the volatility of the fuel to be used in the engine is an important factor in determining the amount of power which an engine of a given size can develop; because, generally speaking, the more volatile the fuel, the less is the heating that must be supplied to the mixture and the greater is the amount of air and fuel which the engine efficiently consumes. In addition to the quite apparent design factors which affect octane requirement there are other more obscure features which have a marked influence on the tendency of an engine to knock. A great deal of time is spent in developing the most satisfactory combustion chamber design to minimize the need for high octane fuels and special attention is given to any effects of combustion chamber design on the formation of carbon deposits. Most commercial engines require gasolines having antiknock values 5 to 15 octane numbers higher when they have accumulated their normal or equilibrium combustion chamber deposits than they do with clean combustion chambers. Therefore, increased attention is being given to designing the combustion chamber so that the engine has the minimum octane requirement after deposit accumulation rather than the minimum octane requirement when clean.

Another engine design feature which merits special consideration from octane requirement standpoint is the effect of the residual charge in promoting detonation. It is almost impossible to purge a combustion chamber completely of combustion products during the exhaust stroke, and the portion of the burned charge that remains in the chamber may have a

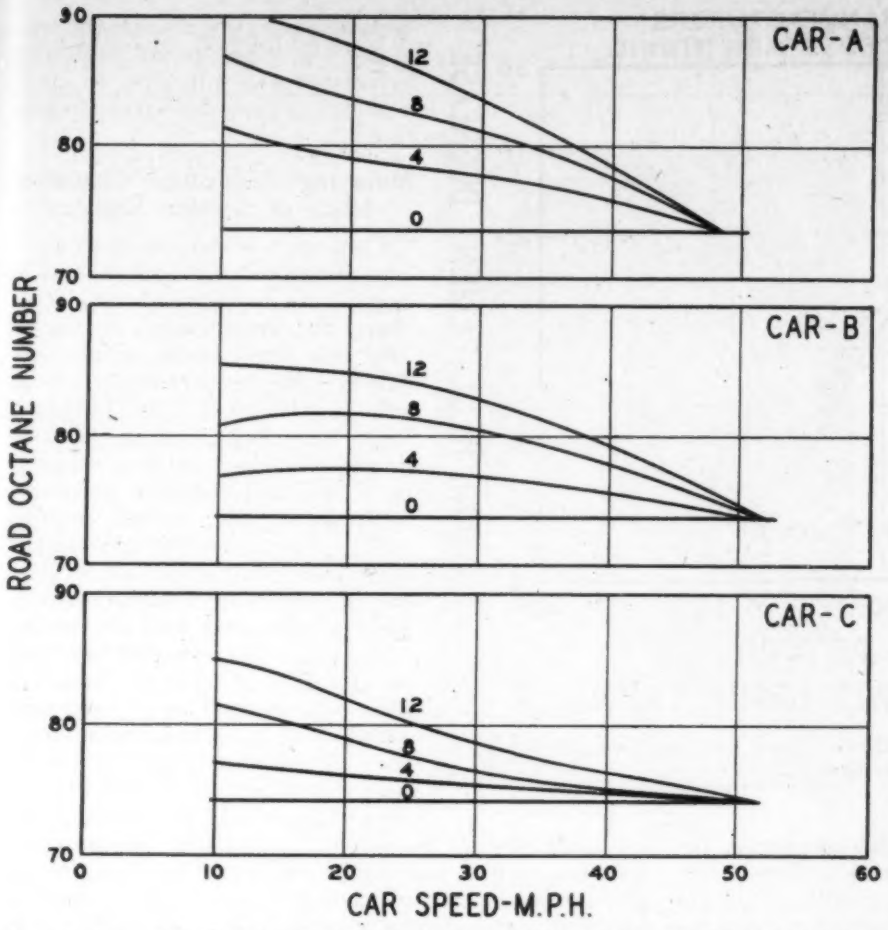

Figure 3. Comparison of Effect of Sensitivity on Road Octane Number in Different Test Cars. (74 Octane Number; 0, 4, 8, 12 Sensitivity.)

tendency to poison the incoming charge and increase the possibility of knock. For this reason, all of the factors which affect engine breathing have an influence on octane requirement. Careful consideration must be given to the cam profile selected, the design of the intake and exhaust ports and manifolds and to the exhaust system; i.e., the amount of back pressure which the exhaust line and muffler develop at high engine speeds when the greatest amount of exhaust products must be handled. It is quite possible that high sensitivity fuels would perform much more satisfactorily at high speeds if the exhaust systems of some of the cars were enlarged or altered so that lower back pressure would exist in the exhaust manifolds and less residual charge would remain in the combustion chamber to promote knocking during the next firing cycle.

Although most of the factors determining the octane requirement of an engine are determined by the engine designer there are a few adjustments available to the serviceman which will influence the fuel requirement of vehicles. For example, the knocking tendency of a high-octane requirement vehicle may usually be lowered by enriching the mixture supplied by the carburetor under the conditions where knock is normally encountered; i.e., at full throttle. This adjustment is usually of limited value, however, because of possible adverse effects upon engine performance.

Basic Spark Timing

Another engine adjustment which has a far greater effect on octane requirement is the basic spark timing. Many servicemen leave the motorist with the impression that the spark advance adjustment is a device provided by the manufacturer for the sole purpose of adjusting the octane requirement of an engine so that knock will never be encountered on the road. While it is true that in most engines the octane requirement can be varied over a wide range by changing the spark timing, such changes result in other penalties which are frequently not recognized.

Figure 4 indicates how the power output and the octane requirement of the average passenger car is affected by retarding the spark timing from that required for maximum power under full throttle conditions. It may be noted that an almost linear reduction in octane requirement results from retarding timing whereas the reduction in spark advance has a very non-linear effect on the power output with successive spark retard increments producing progressively larger percents of power loss. Most car manufacturers take advantage of the flat power output-spark relationship near maximum power spark timing and specify a spark advance which is about 5° retarded (indicated by the broken line on Figure 4) from the spark advance required for optimum power output. This selection of a slightly retarded spark timing results, as indicated in Figure 4, in a slight loss of power (1 to 2 percent and a decrease in octane requirement of approximately 5 octane numbers. However, an additional 5° retard in spark timing (total of 10°) results in a 4 percent loss of power even though the octane requirement has been reduced approximately 13 octane numbers. Additional 5° increments of spark retard decreases the power further (8 and 15 percent, respectively) from that obtained with the maximum power spark advance. In addition to the loss in power, a decrease in economy under part throttle operation is effected by retarding the spark timing beyond that specified by the engine manufacturer. Road test data have indicated that a spark retarded 5° from the maximum economy spark advance will result in a loss of economy of approximately 2 percent under level road operation where maximum economy is most desirable.

Some motorists can detect, in cars which they are driving regularly, power losses as small as 1 percent, but past tests with drivers covering a range of age and experience have indicated that the average motorist can consistently notice a loss in power when it exceeds 2 percent. It would therefore appear that retarding the spark to lower the octane requirement by more than 5° (from the manufacturers' recommended timing) would produce a power loss

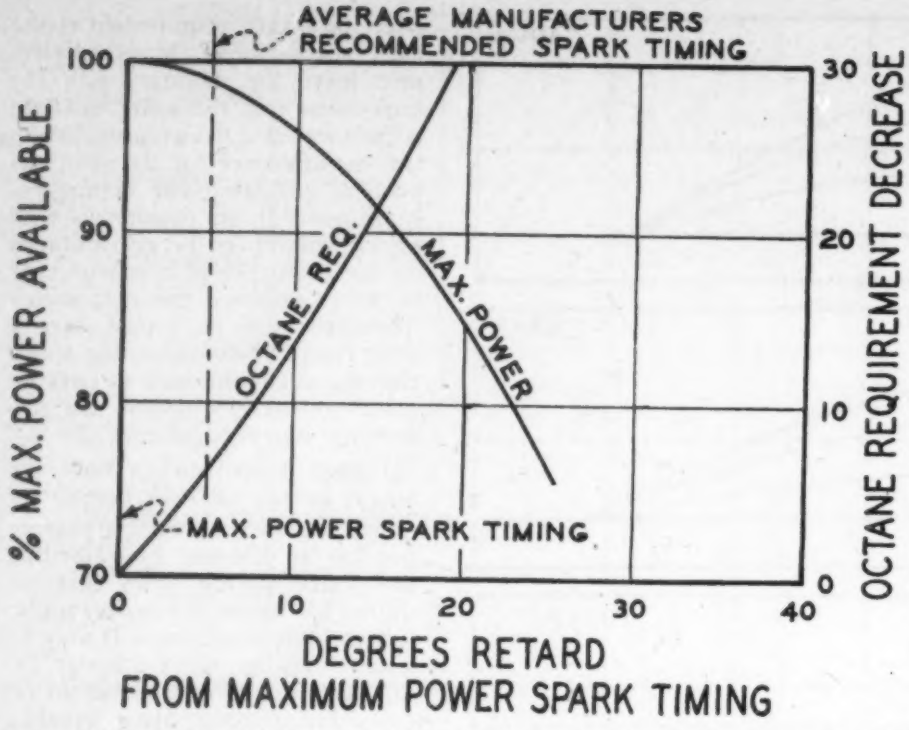

Figure 4. Average Effect of Spark Timing on Octane Requirement and Power Output for 24 Passenger Cars.

in the average car of sufficient magnitude to be readily apparent to the average driver. There are some exceptions to this conclusion as the test previously referred to indicated that some drivers had to have power losses as high as 4 or 5 percent before they could consistently detect them but a change of this magnitude is excessive for the average motorist.

Penalty of Retarding Spark

As discussed above, retarding spark timing lowers the over-all octane requirement of the car. However, the available data indicate that the sensitivity requirement of a vehicle is substantially unaffected by changes in spark timing. It therefore appears that retarding the spark to offset the lack of antiknock quality simply lowers the over-all octane requirement of the car with some penalty of power output and economy, the magnitude of which depends upon the amount that the spark timing is retarded.

Data Lacking

The question which logically arises when considering retarding spark timing is the effect which this change may have on over-all mechanical condition, operating life, and formation of combustion chamber deposits. As far as we know, there is not available sufficient data to determine accurately what degree of spark timing can be tolerated without adversely affecting general engine conditions, but based on general observations of the condition of engines in service, it appears that a moderate degree of spark retard (up to perhaps 5° beyond the manufacturer's setting) will not result in a marked increase in engine deterioration or deposit formation. However, an excessively retarded spark will produce, in addition to the very appreciable power and economy loss previously discussed, an increase in combustion chamber deposits and, at least in the case of some engines, tends to shorten exhaust valve life due to overheating caused by late combustion.

Matching Sensitivity Characteristics of Service Engines

Cars vary widely in both absolute octane requirement and in sensitivity requirement. It is, therefore, impossible to supply any one fuel which would just satisfy the requirements of all vehicles because, cars having a high low speed octane requirement will knock on low sensitivity fuels and vehicles having a high speed high octane requirement will encounter knocking at high speed, full throttle operating conditions. It is, therefore, necessary for the individual fuel manufacturer to determine on the basis of the best available statistical data what octane level is required to serve best his marketing territory. The preparation of proper fuel specifications are usually further complicated by refining factors such as stock availability and by other performance features, such as matching volatility to the changing climatic requirements of each portion of the territory in which the gasoline is to be used. Almost invariably, when a blend of stocks is made to produce a fuel of either a different octane number or sensitivity there is an accompanying change in some of the other significant properties of the fuel such as volatility, heating value, lead susceptibility, sulfur content, etc. In this connection it may be pointed out that natural gasoline is an indispensable blending stock because of its volatility which provides the refiner with the means of controlling the starting and warm-up characteristics of the final fuel. Its generally high octane level and good lead susceptibility are additional factors in its favor which permit its use in relatively high concentrations when required.

Summary

The items of major importance covered in this report may be summarized as follows:

1) There is an optimum sensitivity for each vehicle which will provide a uniform degree of freedom from knocking or a constant knock intensity under most full throttle operating conditions if the fuel octane number is too low.

2) Use of fuels having sensitivities appreciably different from that required by a given engine will result in knock under certain combinations of speed and load at full throttle or will result in an excessive antiknock margin under certain operating conditions if the car is adjusted for knock-free operation on the fuel of the wrong sensitivity.

3) Lowering the octane requirement of the car by retarding the spark will result in appreciable penalties in the form of lost power and economy, accelerated deposit build-up and overheating of the engine if the degree of retard from the manufacturer's setting exceeds several degrees.

REFINER AUTHORS . . . . . and OTHER PERSONALITIES

LSU Faculty Men Write for This Issue

"SIMPLIFIED Multi-Component Fractionation Calculations" in this issue of PETROLEUM REFINER (starts on page 98) is the joint effort of two chemical engineers from the Pelican and Wonder states, Jesse Coates and Raymond V. Bailey, respectively.

Glancing through Jesse Coates' biographical notes, we find an old story repeated. It seems that he was born and raised in Baton Rouge, but like all young fellows he had to travel before he realized that where he really wanted to live and work was right back in his home town. Now he is professor of chemical engineering at Louisiana State University—a man with a lot of energy and the determination to make his school the best in chemical engineering.

Coates was graduated from LSU (B.S. Chemical Engineering) in 1928; spent a year in graduate study at Massachusetts Institute of Technology, and obtained his M.S. and Ph.D. from the University of Michigan in 1932 and 1936, respectively. These latter degrees he mixed up with practical experience as a chemist and treating engineer with National Lumber and Creosoting Company at Alexandria where he equipped their laboratory for testing of raw materials and products of wood preservation plants and operated the wood treating unit. Then he was chemist for the International Company at Bastrop.

Later he spent six months (Cuban sugar season) in San Herman, Oriente, Cuba, for the Punta Alegre Sugar Company. After a year, 1932-33, in Fort Worth, Texas with Texas Pacific Coal and Oil Company, in operation and development of an experimental vapor phase cracking unit, where he got oil on his hands, Jesse went to Houston (closer to Louisiana) for United Gas Public Service Company and worked on water analysis and gas analysis calculations for natural gasoline plants.

And in September, 1936, he went back to Baton Rouge. As assistant professor of chemical engineering, he taught, developed the chemical engineering laboratory, and opened new courses in that field. He became an associate professor of chemical engineering in 1942 and a professor in 1947.

Presently Coates is teaching seven of the toughest chemical engineering courses offered by the University, which includes plant design, thermodynamics, and advanced unit operations, and is directing research in the fields of fluid flow, heat flow, distillation, and liquid-liquid extraction. In addition to his consulting engineering work, he writes extensively. He is a member of Alpha Chi Sigma, Sigma Iota, Phi Lambda Upsilon, Tau Beta Pi, American Chemical Society, and American Institute of Chemical Engineers.

But that isn't all! He is an expert at hunting, fishing, camping, cooking, household repairs . . . and to top it all, he is a gadgeteer.

R. V. BAILEY

JESSE COATES

Raymond V. Bailey was born in Strong, Ark., in 1923. As a final touch to his technical schooling, he came off with a B.S. (*cum laude*, no less) in Chemical Engineering from Louisiana Polytechnic Institute in 1944. His first job was chemist for Cities Service Refining Corporation at Lake Charles, which lasted one year. Then he was chemist at the 6th Army Regional Laboratory, Presidio of Monterey, Calif., until September 1946. Since then he has been a graduate student and graduate assistant in Chemical Engineering at LSU.

He admits to slipping from the lab for hunting or fishing, and owns up to liking mathematics—simplified calculations, empirical equations and nomography—a man after our own heart. He is a wizard at watch repairing (for a nominal fee) and enjoys his card games—old maid, poker, and bridge.

Bailey is a member of Delta Alpha Rho, Gamma Epsilon, and Tau Chi Sigma LSU honorary engineering, scholastic, and chemistry societies, respectively.

Tough Topic Brought "Down to Earth"

A. M. WHISTLER

ARTHUR M. (ART) WHISTLER, consultant for process engineering and supervisor of research for C. F. Braun & Company Alhambra, Calif., is a process engineer from the word "go."

A California Institute of Technology graduate, 1922, Whistler has been with Braun since 1926. He has handled many a figure on engineering multi-component fractionation, heat exchange problems, and bubble columns. In addition, he has engaged in a great deal of research on these same items. As project engineer, he has dealt with absorption plants, fractionating units, a thermal cracker, a fluid cracker, and a number of special units.

He is a friendly fellow, believes in the future of the engineer, and does everything he can to help young engineers under his supervision to achieve sound technical training. His long suit is mathematics.

Whistler writes his articles and papers using some pretty complex mathematics in treating with process design; however, in the article of this issue of

PETROLEUM REFINER, "Heat Exchangers as Money Makers" he brings a subject that can be very complicated down to earth and tells the boys just how it should be done. See page 83.

Whistler's papers before the CNGA and other technical associations are always of great interest for their timely and reliable information.

GEORGE A. LARSEN

Quarter of Century Instrument Service

A NATIVE Texan, born and educated in Clifton and a graduate of Clifton Junior College, George A. Larsen, author of "Instrument Installation and Maintenance Methods and Practices in a Modern Oil Refinery" (starts on page 103) joined The Texas Company in 1922 as an apprentice instrument mechanic. This was at the Port Arthur, Texas, works. The following year he was transferred to the company's Casper, Wyo. refinery as instrument foreman. In 1928 he became electrical and instrument foreman, working with all the company's refineries in the Northwest. This continued until 1942 when he was appointed foreman of the Lockport, Ill., works instrument department, his present position.

His family comprises his wife and two children, a daughter 18 and a son 15. Now and then he manages to go hunting and fishing both of which he claims as hobbies.

Brown Made Fellow

Richard P. Brown, chairman of the board of Brown Instrument Company, Philadelphia industrial instrument manufacturer, has been made a Fellow of the American Society of Mechanical Engineers.

Brown, a director of Minneapolis-Honeywell Regulator Company, holds 54 patents on industrial recording and control instruments. He recently was awarded an honorary degree of doctor of engineering by Drexel Institute of Technology. He is the son of Edward Brown, a pioneer in the industrial instrument business in this country.

Little Time Lost Finding Their Niche

AFTER a minimum of checking, it would appear that the boys who know what makes the wheels go 'round, E. J. McLaughlin and J. A. Miller, co-authors of the CNGA paper, "Significance of Fuel Sensitivity in Performance of Motor Gasolines" (starts on page 112) knew exactly the type of job they wanted after college, because their first jobs are with California Research Corporation.

McLaughlin was graduated from the Oregon State College School of Mechanical Engineering in 1935 and went to work as research engineer in the engine fuel research laboratories. He has been assigned to research projects covering various phases of the motor, aviation, marine, and Diesel fuel fields during that time.

McLaughlin likes his work and is considered an authority in his field. He has been supervisor of the Fuel Research Engine Laboratory from 1943 until January of 1947, when he became supervisor of the Engine Fuels Division. Despite a heavy schedule of duties, he still finds time for the Society of Automotive Engineers and Institute of Aeronautical sciences, in addition to several national fuel research committees.

Miller is a graduate of the School of Mechanical Engineering of the University of California, 1937. Shortly thereafter, he accepted a commission as an engineering officer in the Navy. After extensive periods in combat vessels in the European theater, he returned to civilian life in 1945 and joined California Research Corporation. He is specializing in motor gasoline research and presently is working on research projects dealing with the performance of experimental motor fuels in the laboratory and on the road. He is a member of the Society of Automotive Engineers.

Lott Named Head of Oil Economics Unit

Frederick S. Lott, assistant chief of the Petroleum Economics Division of the Bureau of Mines for the past five years, has been promoted to chief of the division, succeeding Alfred G. White, chief of the division since 1936. White has been relieved of administrative duties to devote full time to forecasts of petroleum demands, a field in which he is a recognized authority.

A part of the economics and statistics branch of the Bureau, the Petroleum Economics Division which Lott now heads, provides economic statistics and surveys of production, distribution, consumption and trends of petroleum, natural gas, natural gasoline, and related products. E. W. Pehrson is chief of the branch.

A 1922 graduate of the U. S. Naval Academy, Lott joined the Bureau of Mines in 1936 as an economic analyst specializing in natural gas.

Above is shown the trio of Allen brothers honored at The Pure Oil Cabin Creek, W. Va., refinery's 30th anniversary celebration, left to right, Burl, Earl and Wheeler. Their service totals 85 years at the refinery. Twenty-five other veterans were at anniversary dinner which was addressed by L. S. Wescoat, president, J. P. Langfitt, vice president for refining, and Comer Plummer, vice president for producing, all of Chicago. Superintendent C. W. Cooper presided and two past superintendents, James R. Palmer and James C. Megraw, took part in the celebration. Three veterans have worked 30 years or more at the refinery or with the company. They are Elmer Jarrell, assistant operator in the distillation department; D. F. Jernigan, assistant operating foreman, and William L. Dulaney, general maintenance foreman.

Evans Nominated by Petroleum Institute

The Institute of Petroleum, London, has nominated E. A. Evans, M. I. Mech. E., F. Inst. Pet., as president designate of the Institute for the session 1948-9.

Evans, who has been chief chemist to the Wakefield group of companies since 1915, is well-known in the field of lubrication. He has also been chairman of the Motor Industry Research Association since its inception in March, 1946. He was chairman of its predecessor—the Automobile Research Committee—during 1944 and 1945 and chairman of its research sub-committee from 1941 to 1943. In 1942-3 he was awarded the Crompton Medal of the I.A.E for his paper on "Extreme-Pressure Lubrication."

Warner Given New Work at Carnegie

Dr. J. C. Warner, professor and head of the department of chemistry and dean of graduate studies at Carnegie Institute of Technology, has been appointed an assistant director of the college of engineering and science and will "direct, summarize the results of, and interpret such surveys and studies as are necessary to determine the future financial needs of the College and the equitable distribution of current resources among the various departments of the College."

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Refinery and Other Plant Construction

FURTHER revisions are contained in this month's "box score" detailing refinery and other plant construction projects. The "box score" first appeared in the September issue of PETROLEUM REFINER and since that time has become very popular. A number of suggestions have been received and these, together with other data sent in by readers, give promise toward making the compilation more and more complete as the industry becomes advised as to its purpose and intent.

Companies whose projects are not listed are urged to:)1 send in data on units not listed; 2) furnish details which are missing in the current tabulation and 3) report from time to time on progress of such work. Such helpful cooperation will be very much appreciated.

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Agwi Pet. Corp.	Fawley, Eng.	.....	120,000 bbls.	$140 million	Projected	1952	.....	.....	.....
*American Republics Corp.	Silsbee, Texas	Gasoline Plant	.....	.....	.....	.....	.....	.....	Gasoline Plant Constr. Co.
Atlantic Ref. Co.	Philadelphia, Pa.	Propane, lubes Wax Plant	3,800 bbls.	.....	Under Constr.	Early '48	JUIK, Texaco	Badger, Atalntic Kellogg & Lummus	Badger, Lummus Kellogg Atlantic, Lauter Constr.
*Atlantic Refg. Co.	Dallas, Texas	Geop. Lab. Bldg.	.....	.....	Under Constr.	'48	.....	Atlantic	Wohlfeld
Barsco Oil Co.	Wichita, Kans.	Cat. desul. Reforming	7,500 bbls.	$500,000	Under Constr.	Early '48	Phillips	Koch Eng. Co.	Koch Eng.
Barnsdall Oil Co.	Benton, La.	Gasoline Plant	.....	.....	Under Constr.	.....	.....	.....	Lummus
*British Pet. Chem., Ltd.	Grangemouth, Scotland	Petro-chem	.....	.....	.....	.....	.....	.....	.....
*The California Oil Company	Rangely, Colo.	Gasoline Plant	25,000 gals.	$3 million	Under Constr.	'48	.....	Hudson	Hudson
Caltex Pet. Maatschappij, N.V.	Rotterdam, Holland	Crude Plant	20,000 bbls.	$18 million	Projected	Early '50	.....	McKee	McKee
Carter Oil Co.	Billings, Mont.	Crude Cat Crk.	30,000 bbls.	$20 million	Under Constr.	3rd Qtr. 1949	.....	U.O.P., S.O.D.	Fluor Corp.
Carthage Corp.	Carthage, Field	Gasoline Plant	100,000 mcf	$3.5 million	Under Constr.	Jan. 1, '49	.....	Hudson	Hudson
Carthage Hydrocol, Inc.	Brownsville, Tex.	Hydrocol	64,000 mcf	$19 million	Under Constr.	1948	Hydro-Res. Inc., Texaco	McKee	McKee
Citcon Corp.[1]	L. Charles, La.	Lube Plant	6,000 bbls.	$30 million	Under Constr.	.....	Texaco	.....	Lummus, Max. B. Miller
Cities Service Oil Co. (Delaware)	E. Chicago, Ill	Modernize plant	.....	$18 million	Under Constr.	Late '48	Kellogg	Kellogg	Kellogg
Cities Service Oil Co. (Delaware)	E. Chicago, Ill	Laboratory	.....	$300,000	Under Constr.	Spring '48	.....	Cities Service	Sumner-Sollitt
Consolidated Ref., Ltd.	Haifa, Palestine	Crude Plant	124,000 bbls.	.....	.....	By 1950	Lummus, Kellogg	Lummus	Badger
Continental Oil Co.	Billings, Mont.	Cat Cracking	7,500 bbls.	$8.5 million	Contract signed	1949	U.O.P.	U.O.P.	J & L Supply
Continental Oil Co.	Denver, Colo.	Crude, Cat Crk.	7,500 bbls.	$4 million	Under Constr.	Fall 1948	Houdry Corp. & U.O.P.	Con. Oil Co., Lummus	Lummus
*Continental Oil Co.	Sonora, Texas	Gasoline Plant	.....	.....	.....	.....	.....	.....	Brown & Root
Creole Pet. Corp.	Amuay Bay, Venesuela	Cat Cracking	60,000 bbls.	$70 million	Under Constr.	1950	.....	.....	.....
*Creole Pet Corp.[2]	Multa Field, Venesuela	Stabilisation and Repressuring Plants	.....	.....	.....	.....	.....	.....	.....
*Creole Pet. Corp.[3]	El Roble Field, Venesuela	Repressuring	.....	.....	.....	.....	.....	.....	.....
Egyptian Government	Egypt	Crude Plant	.....	.....	.....	.....	.....	Lummus	Lummus
Ethyl Corp.	Baton Rouge, La.	Mfg. Facilities	.....	$20 million	Announcement	.....	.....	.....	.....
Gray-Wolfe Co.	Montgomery Co.	Gasoline Plant	13,000 mcf	$2 million	Under Constr.	Jan., 1949	.....	O. L. Olsen	O. L. Olsen
*Gulf Oil Corp.	Eunice, N. M.	Gasoline Plant	.....	.....	.....	.....	.....	Hudson	Hudson
Gulf Oil Corp.	Crane Co., Tex.	Gasoline Plant	23,000 mcf	.....	.....	.....	.....	.....	.....
Gulf Oil Corp.	Pt. Arthur, Tex.	Crude, Poly-Perco	.....	.....	Under Constr.	Early '48	Gulf-Phillips	Badger, Lummus	Badger, Lummus
Gulf Oil Corp.	Philadelphia, Pa.	Polyform	.....	.....	Under Constr.	.....	Gulf-Phillips	Lummus	Lummus
Gulf Ref. Co.	Toledo, Ohio	Crude Unit	.....	.....	Under Constr.	Early '49	.....	Badger	Badger
*Hiwan Oil Co.	Arkansas	Gasoline Plant	.....	.....	.....	.....	.....	Petro. Eng.	Petro Eng.
Humble O & R Co.	Baytown, Tex.	Lube Plant	.....	$5 million	Under Constr.	Early '48	Texaco	Badger	Badger
Humble O & R Co.	East Texas	Gasoline Plant	.....	$2 million	Under Constr.	.....	.....	Fish Eng. Corp.	.....
Humble O & R Co.	Katy, Texas	Propane, Butane Extraction	10,000 bbls.	$7 million	Contract let	.....	.....	.....	Stearns-Roger
Humble O & R Co.	Refugio, Texas	Gasoline Plant	35,000 mcf	$2.5 million	Under Constr.	1948	.....	.....	Gaso. Plant
Industrie Chimiche Italiane Petroli	Mantau, Italy	Crude	4,500 bbls.	.....	.....	.....	.....	.....	.....
Jefferson Chem. Co.	Pt. Neches, Tex.	Petro-chem	.....	.....	Under Constr.	1948	.....	Jefferson	Jefferson, Badger Lummus
Kanotex Refg. Co.	Arkansas City, Kans.	Cat Cracking	4,200 bbls.	500,000	Contract let	Early '48	Phillips	Koch Eng.	Koch Eng.
Magnolia Pet. Co.	Beaumont, Tex.	Lube Plant	.....	.....	Under Constr.	Jan. 1, 1949	Texaco	Lummus	Lummus, Kellogg
Magnolia Pet. Co.	Seeligson Field, Texas	Gasoline Plant	90,000 mcf	.....	.....	Late '48	.....	Hudson	.....
Fred M. Manning, Inc.	Stephens Co., Texas	Pressure Maintenance	20,000 mcf	$500,000	Contract let	Jan. '48	.....	Fish Eng. Corp.	.....
McCarthy Chem. Co.	Winnie, Texas	Petro-chem, Cat Cracking	5,000 bbls.	$3 million	Under Constr.	.....	Phillips	Fish Eng. Corp.	.....
*Mene Grande	West Guara, Venesuela	Repressuring	.....	.....	.....	.....	.....	.....	.....
Mid-Continent Pet. Co.	Tulsa, Okla.	Vac still, Cat Cracking	45,000 bbls.	$8.5 million	Contract let	June, '48	Kellogg	Kellogg	Kellogg
Monsanto Chem. Co.	Texas City, Tex.	Rebuilding Petro-chem	.....	$6 million	Contract let	.....	.....	.....	Bellows Co., Leon Con. Co.
National Co-Op. Ref. Assn.	McPherson, Kansas	Cat Desul and Ref. Unit	5,000 bbls.	$400,000	Under Constr.	Late '47	Phillips	Koch Eng.	Koch Eng.
Ohio Oil Co.	Robinson, Ill.	Vac Unit, Cat Cracking	27,500 bbls.	$15 million	Under Constr.	Late '48	U.O.P.	McKee	McKee, Pritchard
Petro Carbon, Ltd.	Partington, Eng.	Cat Cracker, Lube & Reform	20,000 bbls.	.....	.....	.....	.....	.....	.....
Petro Chem., Ltd.	Partington, Eng.	Petro Chemicals	.....	.....	.....	.....	.....	.....	.....
Petrol Terminals	Texas City, Tex.	Cat Cracker (re-condition)	.....	.....	Under Constr.	Late '47	.....	.....	Cat. Constr.
Petroleos Mexicanos	Salamanca, Mex.	Crude, gasoil Cracking	30,000 bbls.	$12 million	Contract let	1949	U.O.P.	McKee	McKee
Plomo Co.	Neuces Co., Tex.	Gasoline Plant	.....	.....	Awaiting Appr'l	.....	.....	.....	.....
Porto Marghera Rfg.	Venice, Italy	Enlarging	.....	.....	.....	.....	.....	.....	.....
Pure Oil Co.	Smith's Bluff, Texas	Lube Plant	.....	$9 million	Contract let	.....	Texaco	Lummus	Lummus
Richardson and Bass	Keystone Field, Texas	Gasoline Plant	70,000 mcf	.....	Constr.Appr'vd	10-1-48	.....	J & L Supply	J & L Supply

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Chemical Corp.	Thornton, Eng.	Petro-chem	.....	Several millions	Under Constr.	.....	.....	.....	.....
Shell Chemical Corp.	Shell Haven, England	Petro-chem	.....	.....	.....	.....	.....	.....	.....
Shell Chemical Corp.	Stanlow, Eng.	Petro-chem	.....	.....	.....	.....	.....	.....	.....
Shell Chemical Corp.	Houston, Texas	Glycerine	.....	Part $35 mln.	Under Constr.	Early '48	.....	.....	Braun
Shell Chemical Corp.	Shell Pt. Calif.	Syn. Ammonia	.....	.....	.....	Early '48	.....	.....	.....
Shell Oil Co.	Notrees, Texas	Gasoline Plant	45,000 mcf	$4 million	Under Constr.	March '48	.....	Brown & Root	Brown & Root
Shell Oil Co.	Houston, Texas	Lube Unit	.....	$10 million	Under Constr.	.....	Texaco	Lummus	Lummus
Shell Oil Co.	Denver City, Tex.	Gasoline Plant	24,000 mcf	.....	Under Constr.	1948	.....	.....	Fluor Corp.
Shell Oil Co (Venezuela)	Cardon, Venezuela	Complete Refg.	.....	.....	Under Constr.	.....	.....	Lummus	Lummus
Sinclair Refg. Co.	E. Chicago, Ill.	Lube Plant	.....	.....	.....	.....	.....	Lummus	Lummus
Socony-Vacuum Oil Co., Inc.	Paulsboro, N.J.	Crude, Lube Plant	.....	.....	Under Constr.	Jan. 1, 1949	Texaco	Badger	Badger
Socony-Vacuum Oil Co., Inc.	Casper, Wyo.	Cat Cracking	7,500 bbls.	.....	Under Constr.	Jan. 1, 1949	.....	.....	.....
Socony-Vacuum Oil Co., Inc.	E. St. Louis, Ill.	Thermal Cracker & distillation	.....	.....	Projected	Jan. 1, 1949	.....	.....	.....
Socony-Vacuum Oil Co., Inc.	Augusta, Kans.	Cat Cracking	10,000 bbls.	.....	Projected	Jan. 1, 1949	.....	Cat. Constr. Co.	Cat. Constr. Co.
Stanolind O & G Co.	Elk Basin, Wyo.	Gasoline Plant	12,000 mcf	.....	Approved	.....	.....	Stone & Webster	Stone & Webster
Stanolind O & G Co.	Slaughter, Texas	Gasoline Plant	90,000 mcf	.....	Approved	.....	.....	Braun	Braun
Stanolind O & G Co.	Hugoton Field, Kansas	Gasoline Plant	150 mcf	.....	Approved	.....	.....	J & L Supply	J & L Supply
Stanolind O & G Co.	Hugoton Field, Kansas	Gas syn. Plant	100,000 mcf	.....	Announced	.....	.....	Hydro Res.	Kellogg, Foster Wheeler, Stone & Webster
Stanolind O & G Co.	Hockley County, Texas	Gasoline Plant	.....	.....	.....	.....	.....	.....	.....
Stanolind O & G Co.	Hugoton Field, Kansas	Chemical Plant	130,000 lbs./yr.	.....	Announced	.....	.....	Badger	Badger
Stanolind O & G Co.	Brownsville, Tex.	Chemical Plant	130,000 lbs./yr.	.....	Announced	.....	.....	Badger	Badger
Stanolind O & G Co.	Pettus, Texas	Cycling Plant	159,000 mcf	.....	Projected	1949	.....	J & L Supply	J & L Supply
*Stanolind Oil & Gas Co.	Ulysses, Kan.	Gasoline Plant	100,000 mcf.	.....	Projected	.....	.....	.....	.....
Standard Oil Co. (Indiana)	Sugar Creek, Missouri	Cat Cracking	25,000 bbls.	.....	.....	Early '48 •	.....	.....	Kellogg
Standard Oil Co. (Indiana)	Whiting, Indiana	Cat Cracking	25,000 bbls.	.....	.....	Early '48	.....	Lummus S.O.D. & Braun	Kellogg, Lummus Braun.
Standard Oil Co. (New Jersey)	Linden, New Jersey	Vac. Cat Cracking, pipe still coker	90,000 bbls.	.....	Contract let	1st Qtr. 1949	.....	S.I.D. & Braun	Braun
Standard Oil Co. (New Jersey)	Baton Rouge, Louisiana	Lub. Vac. still, Crude, Dewax, poly	111,500 bbls.	.....	Under Constr.	Early '48	Texaco	Badger, S.O.D., Braun, McKee, Kellogg	Badger, Kellogg, McKee, Braun
*Standard Oil Co. (California)	Bakersville, California	Crude dist, Cat Cracking	10,000 bbls.	$7.5 million	Announced	Mid '49	.....	.....	.....
*Standard Oil Co. (California)	Salt Lake City, Utah	Crude dist. unit	25,000 bbls.	$5 million	Announced	Late '48	.....	.....	Bechtel
Standard Oil Co. (California)	Richmond, (California)	Grease	82,000 lbs.	$5.2 million	Under Constr.	Sept. '48	U.O.P.	W. G. Peugh	Barrett & Hilp
Standard Oil Co. (Ohio)	Lima, Ohio	Cat Cracking	6,000 bbls.	$10 million	Contract let	Late '49	U.O.P.	McKee	McKee
Stora Kopparberg	Sweden	Crude, Ther. Cracking	.....	.....	.....	.....	.....	Lummus	Lummus
Sun Oil Co.	Richland Parish, Louisiana	Gasoline Plant	70,000 gal.	.....	Under Constr.	.....	.....	.....	Pet. Eng., Inc.
Sunray Oil Co.	Duncan, Okla.	Crude Plant	20,000 bbls.	.....	Under Constr.	Late '47	.....	U.O.P.	.....
The Texas Co.	Eagle Pt., New Jersey	Vac. still, Cat Cracking	40,000 bbls.	.....	Contract let	Late '49	.....	Kellogg, Texaco Co.	Kellogg, Foster Wheeler
The Texas Co.	Lawrenceville, Illinois	Crude and Cat Cracking	20,000 bbls.	.....	Announced	1950	.....	Foster Wheeler	Kellogg, Foster Wheeler
The Texas Co.	W. Tulsa, Okla.	Crude and Cat Cracking	30,000 bbls.	.....	Contract let	1949	.....	Texas Co., Kellogg, Foster	Kellogg, Foster Wheeler
The Texas Co.	Port Arthur, Texas	Lube addition	2,000 bbls.	.....	Under Constr.	Late '48	.....	Texas Co., Foster Wheeler	Foster Wheeler
The Texas Co.	Casper, Wyo.	Cat Poly Naphtha, reformer, Press. Coker	10,000 bbls.	.....	Completed	.....	Kellogg	Kellogg	Kellogg
*Utah Oil Refg. Co.	Salt Lake City, Utah	Expand existing Refinery	25,000 bbls.	$2.5 million	Announced	Late '48	.....	.....	.....
Winnsboro Refg. Co.	Winnsboro, Tex.	Crude Plant	3,000 bbls.	$175,000	Under Constr.	Jan. 1, '48	.....	.....	Mid-Continent
*Witco Hydrocarbon Corp.	Barnhart Field, Texas	Gasoline Plant	2,000 bbls.	.....	Contract let	July '48	.....	Fish	Fish
Wood River Oil & Refg. Co.	Hartford, Illinois	Cat Cracking, gasoil, Cracking	8,500 bbls.	$1 million	Under Constr.	Late '48	Phillips	Koch Eng.	Koch Eng.

NOTE:— Atlantic—The Atlantic Refining Co. Badger—E. B. Badger and Sons. Bellows—W. S. Bellows Co. Braun—C. F. Braun Co. Cat. Constr.—Catalytic Construction Co. Fish Eng.—Fish Engineering Corp. Fluor—Fluor Corporation. Gaso. Plants—Gasoline Construction Co. —Houdry—Houdry Corp. Hudson—Hudson Engineering Corp. Hydro Res.—Hydrocarbon Research, Inc. Jefferson—Jefferson Chemical Co. J & L Supply—Jones & Laughlin Supply Co. Koch Eng—Koch Engineering Co. Kellogg—M. W. Kellogg Co. Leon Constr.—Leonard Construction Co. Lummus—The Lummus Co. McKee—Arthur G. McKee Co. Phillips—Phillips Petroleum Co. Pet. Eng.—Petroleum Engineers, Inc. Pritchard—J. F. Pritchard & Co. Stearns-Roger—Stearns Roger Manufacturing Co. Texaco—Texaco Development Co. Wohlfeld—Wohlfeld Construction Co. [1] Jointly owned by Cities Service Oil Co. and Continental Oil Co. [2] Jointly owned with Pantepec Oil Co. [3] Jointly Owned with Pantepec Oil Co.
* First appearance in tabulation.

McCarthy Chemical Units To Be Completed Soon

McCarthy Chemical Company plans to place in operation early this year processing units now under construction at Winnie, Texas. Aromatics, such as benzene and ethylene, will be the initial products manufactured. As building materials become available other hydrocarbon products and their secondary products will follow.

The McCarthy refinery and gasoline plant adjoining the chemical plant, is processing approximately 100 million cubic feet of gas a day and ultimately, (early 1949) expects to process 250 million cubic feet. At this anticipated rate of consumption, company officials estimate the existing McCarthy supply sufficient to last in excess of 30 years.

California Standard Units

A $7.5 million construction program to expand and modernize the Bakersfield refinery of Standard Oil Company of California will include the latest in crude distillation and cracking facilities, an office building and laboratory, and modern auxiliary equipment.

Capacity of the plant will be increased to a crude run of 20,000 barrels of crude daily. Construction work is scheduled to start in the spring of 1948, with completion anticipated by mid-1949.

Pantepec Expansion Plans

In an accelerated program of development, Pantepec Oil Company of Venezuela, C. A. has announced that $6 million will be used in the completion of projects now in progress.

C. U. Daniels, president of Pantepec, stated that credit has been arranged with Chase National Bank of New York for a program which includes completion in the Mulata Field of a stabilization and repressuring plant now under joint construction with Creole Petroleum Corporation and scheduled for operation about December 1948; completing preliminary plans for the construction jointly with Creole, of a stabilization plant to serve the El Roble Field.

COMMERCIAL SYNTHETIC GASOLINE

The McKee organization is supplying engineering, procurement and construction services for the first of two commercial synthetic gasoline plants now being built in the United States.

McKEE

ARTHUR G. McKEE & COMPANY

Engineers and Contractors • Established 1905

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

UNDIVIDED RESPONSIBILITY IN ONE ORGANIZATION

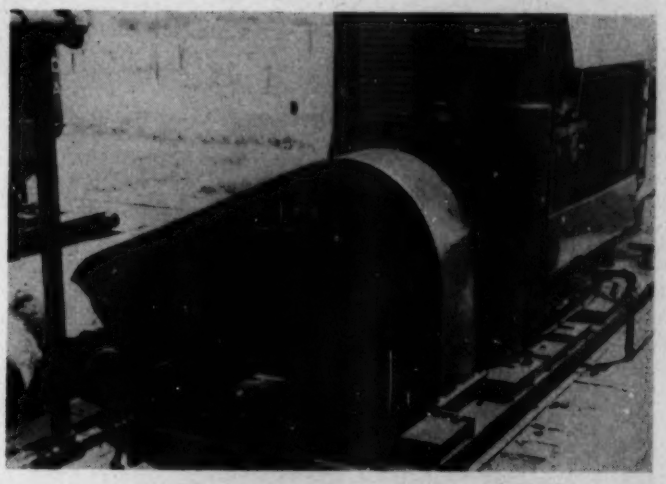
OPERATION HOW TO DO IT MAINTENANCE

HOW TO—

Facilitate Inspection of Guard-Protected V-Belts

GOOD safety practices demand that V-belts of motor-driven pumps be provided with metal guards to protect the personnel working around the pumps. Efficient operation requires inspection of the belts which necessitates the removal of the guards.

Paul Dacke and M. A. Newman of the production department of Humble Oil & Refining Company, eliminated a good bit of the work encountered in removing the guards by hinging one end of the guard to its base, allowing the guard quickly and safety to be raised to inspect the belts. For maintenance on the belts or the belt assembly, the guard can be tilted back far enough to be out of the workman's way during the work period.



Top photo at right shows hinge location on V-belt guard.

Lower photo shows guard raised to allow maintenance or inspection.

HOW TO—

Facilitate Removal Of Drum Contents

A HANDY drum rack that enables a workman easily to place a drum in a position to remove its contents is shown in the above photograph. Workmen of Root Petroleum Company's El Dorado, Arkansas refinery find these racks a handy method of handling drums of lube oil, inhibitor, and other liquids, and use them extensively throughout the plant.

Handy Drum-Handling Arrangement.

HOW TO—

Safeguard CFR Engines For Better Operation

IN THE operation and maintenance of testing engines used to determine the anti-knock value of gasolines and the ignition quality of diesel fuels, several engine test laboratories have developed procedures or accessories that are worthy of more widespread application.

Quite frequently the cetane test operator is given a limited quality of diesel fuel to determine its ignition quality. In making the adjustments necessary to maintain standard operating conditions, not enough of the sample is left to determine the readings required to compile an average. A four-ounce oil sample bottle, filled with water, stoppered, and placed in the fuel bowl will raise the level in the bowl sufficiently to provide adequate fuel for proceeding with the testing of the given sample. By utilizing this idea three readings have been successfully determined with only a pint of sample.

Failure of the power to the dynamometer, which maintains a constant load on the cetane engine, will allow the engine to run away. Instances where considerable damage has been done to the engine and its foundations have occurred. By installing a governor with an automatic cut-off on the fuel supply line of the engine, the engine will be shut down when excessive speed occurs. This installation is well worth the investment as a safeguard to efficient operation.

Often the cooling water to the engines in the motor lab is supplied from the refinery main-line. A drop in pressure occuring by a large demand elsewhere in the plant will cause the engines to overheat from an insufficient volume of cooling water, with the possibility of severe damage to the engines. The installation of a pressure indicator coupled with a warning light or signal horn, apprises the operator of the condition and allows him to take the necessary actions to protect the engine. This installation is particularly helpful in laboratories where the operator has duties other than the operation of the test engines.

HOW TO—

Hold Fire Extinguishers During Refilling Process

Device for Holding Fire Extinguisher During Refilling.

THE refilling of 2½-gallon foam-type extinguishers is a job usually requiring considerable patience and perserverance.

Excessive pressure is necessary when installing the cap in order to bring the safety holes below the cap threads to prevent leaking. By the same token, this same pressure is necessary to remove the cap. The extinguisher is awkward to hold, tips easily, and the body can become damaged by excessive gripping pressure. All in all the job is extremely tedious.

Charles Svobada, fire equipment inspector in the fire protection department of Humble Oil & Refining Company's Baytown, Texas, refinery, devised the above-pictured foot vise which conveniently holds the extinguisher while being filled.

The extinguisher is held firmly in the rubber lined jaws of the vise with any desired pressure by merely pressing down on the foot lever. The pressure is evenly distributed around the base of the extinguisher body preventing any damage to the extinguisher. The cap can be firmly gripped and is conveniently removed with a hand wrench. Tipping and inadvertent mixing of the foam-producing chemicals is precluded. One man is able quickly to accomplish the refilling with a minimum of effort.

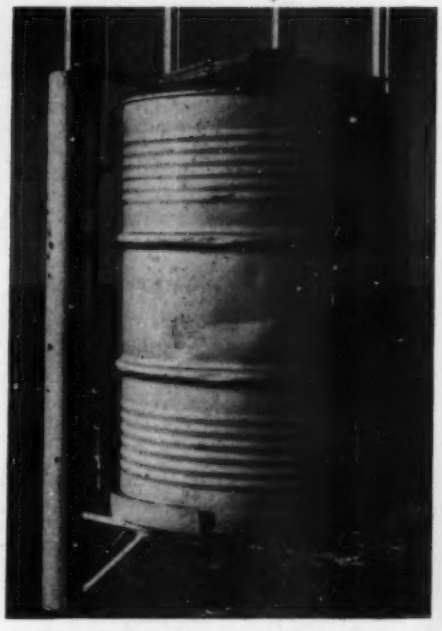
HOW TO—

Promote Idea of Good Housekeeping

ONE of the cleanest plants that one may visit is the Shamrock Oil & Gas Corporation's McKee plant at Sunray, Texas.

Trash barrels often are found to have more trash thrown around them than inside of them. The above photograph illustrates the psychology practiced in promoting good housekeeping at this plant.

Raised off the ground and placed in the open, rags and other trash cannot be hidden back of the barrel. It is easy to remove for emptying. The top of the barrel is attached by a hinge to the supporting post and cannot be left off or lost. Thus the lowly trash container is made to play its truly important part in plant cleanliness.



Efficient Trash Barrel

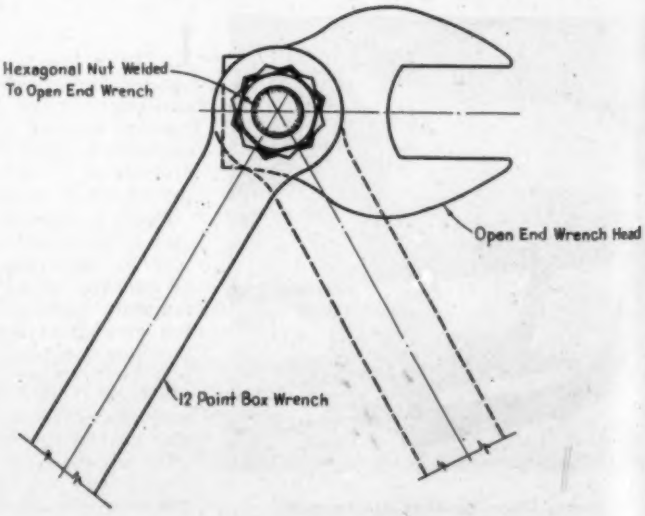
HOW TO—

Make Handy Wrench For Use in Tight Places

A. J. HENSON, assistant district gauger of Humble Pipe Line Company's Odessa, Texas district, has devised a handy adaptation of an open-end wrench for working in tight places.

By welding a hexagon nut near the jaws of the end wrench and cutting off the handle of the wrench as shown in the accompanying sketch, a boxed-end wrench or a socket wrench can be fitted to the hex nut to supply the necessary leverage. The boxed or socket wrench can be placed on the hex nut from twelve different angles, greatly facilitating the use of the wrench.

This adaptation has proved useful in making up flanged fittings in bell-holes where the accessibility to the studs is limited.



Henson's adaptation of open-end wrench for working in tight places.

HOW TO—

Protect Meter By Strainer Installation

John H. Schmid,
Vice President J. A. Zurn Mfg. Co.

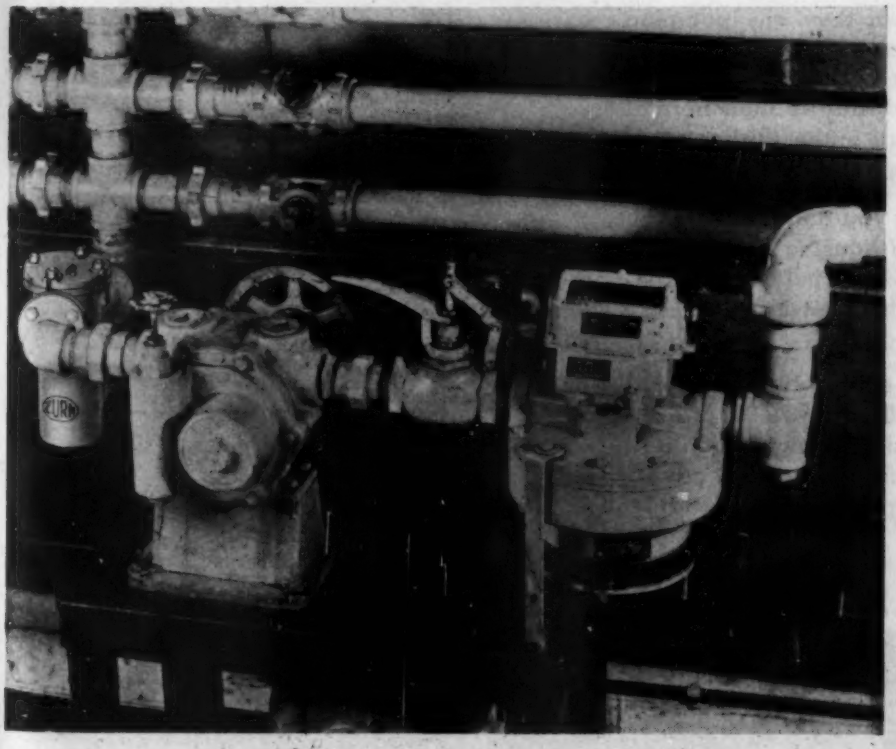
IN BLENDING oils for industrial purposes, Warren Refining & Chemical Company, Cleveland, Ohio pumps measured amounts through a positive displacement meter. Oils from several storage tanks are pumped through a rotary-vane, positive displacement meter into a series of blending vats. Some time ago, a piece of hard metal scored the cylinder valve, valves, and valve plates of the meter. Two days were required to repair the meter, seriously interfering with plant production. Downtime cost, although difficult to compute, was estimated at $200 an hour, which was in addition to the actual cost of repairs, and considerably more serious.

After the accident, a strainer was installed ahead of the unit, as illustrated, and no further damage has occurred.

The strainer also affords protection to the rotary pump, preventing the gears or casing from being scored, or the shaft from being sprung by entrainment in the lines.

An accumulation of dirt within the positive displacement meter will create a drag on the rotary motion which increases the pressure drop, and the resultant loss through the clearances. In addition, the meter vanes have a close tolerance. Sand or abrasive sediment may damage the blades and score the lining so that the meter won't register all of the fluid.

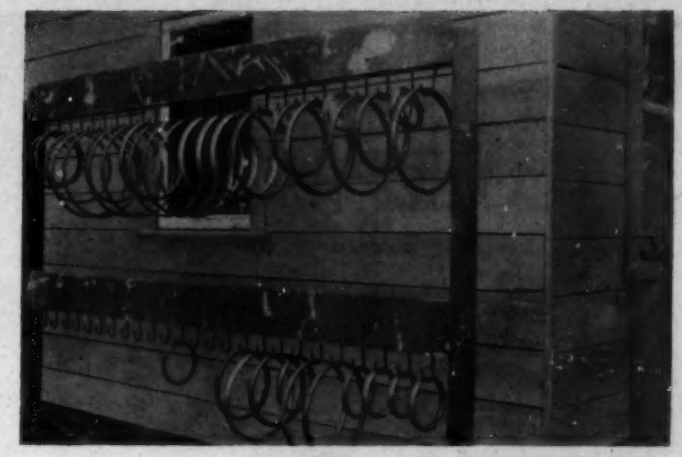
Of course, meters can be recalibrated and adjusted to compensate for the leaks, provided regular checks are made. This permits a certain percentage of loss if the meter is operated without a strainer, since the loss may occur in between checking or recalibrations. The most satisfactory solution both from the standpoint of protection and accuracy is that all positive displacement meters be provided with strainers in their inlet piping.



How installation of strainer can protect positive displacement meter.

HOW TO—

Construct Ring Gasket Rack



Rack for Ring Gasket "On Job" Storage.

DURING a shutdown for cleanout and inspection, time of course is a big factor inasmuch as short cuts bring the unit back on stream earlier. Ring gaskets, for example, may be stacked in cartons to protect from damage, but if a substantial rack is provided, the sizes desired can quickly be selected without looking for labels on some container.

A rack, which may be used during successive shutdowns, is designed to stand upright with two horizontal bars into which are screwed large hooks on the lower edge, each hook to support a single gasket. Placed beside the temporary tool room—moved into the area for convenience—workmen may select the proper type and size for the flanges when reassembling lines and other equipment requiring gaskets of this type.

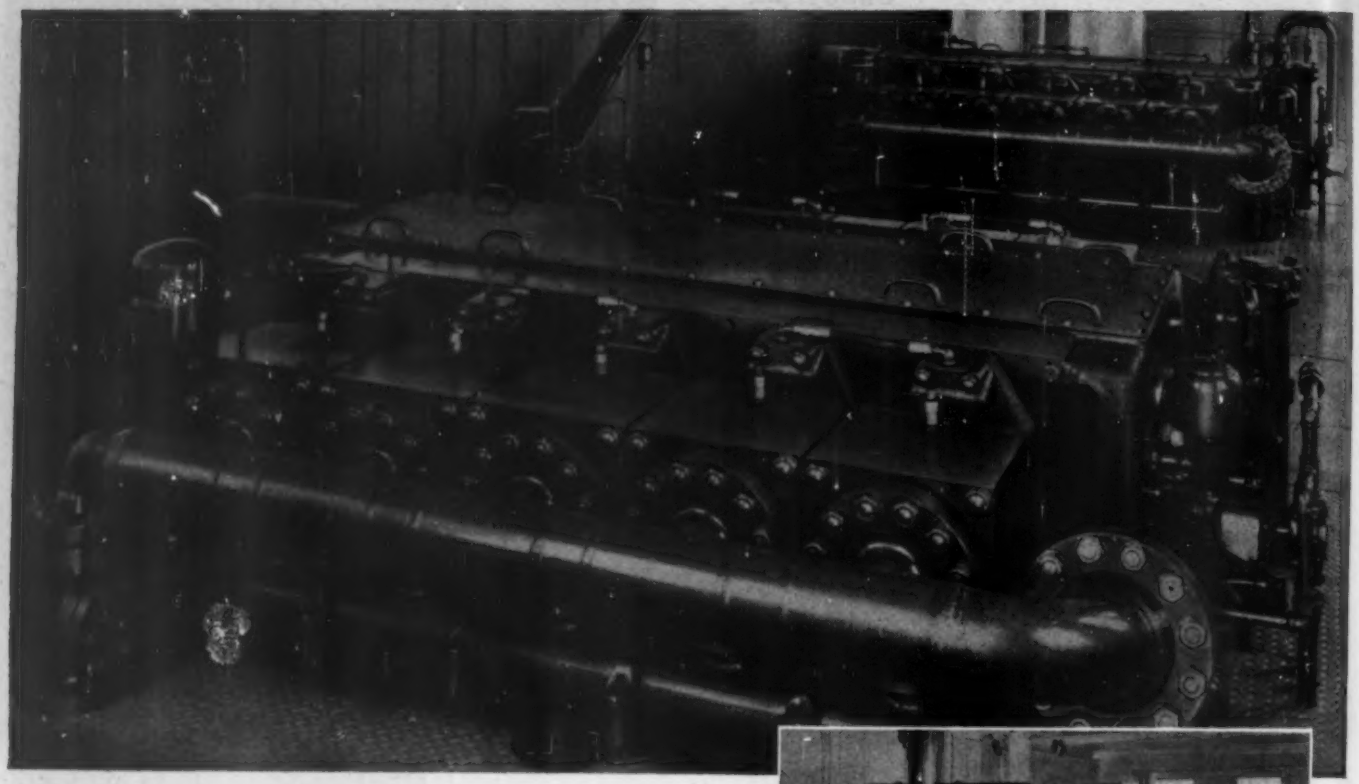
Products Storage Lines Labeled for Ease in Sampling.

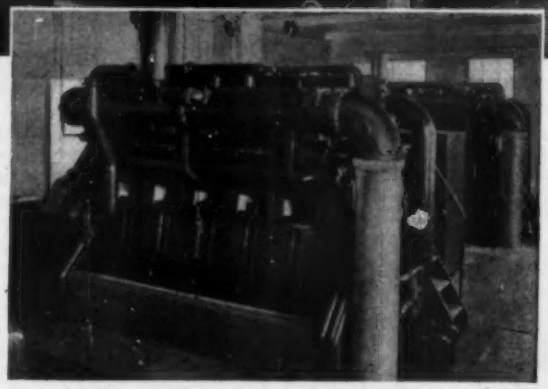
HOW TO—

Label Product Storage Lines for Sampling

TO SIMPLIFY product-to-storage sampling, the product lines from the processing area in the Sheridan cycling plant of Shell Oil Company, Inc., are labeled and equipped with ½-inch valves at a point where the lines leave the overhead piping supports and go underground to the storage tanks. In the above photograph of the installation, the lines are equipped with small metal plates and valves for connection to sample containers. From left to right the lines are distillate, isopentane, gasoline, isobutane, normal butane, propane, rerun, mineral seal lean oil surge, mineral seal storage, naphtha, and purifier bottoms storage. This method permits the operator to take all product samples at a central location, rather than at various points throughout the plant.

PROOF OF PROGRESS IN PUMPING!





HERE, at a pumping station, in the Rocky Mountain area, revolutionary Cooper-Bessemer Twin-Line pumps have been in continuous use for the past 21 months. And here, in the field, they are *proving* the value of their cost-saving features.

Look at the rugged compactness of these new pumps. Although occupying small space, they are pumping 38,000 barrels of oil at 1,200 psi pressure. Their mechanical efficiencies are running over 92%, with volumetric efficiencies from 95 to 97%. And, due to their normal operating speed of 400 rpm, there is the further economy and simplicity of direct-connected engine drive.

If pumping efficiencies can save you dollars . . . if you want to economize in the cost of housing and maintenance . . . if you can benefit by extremely wide capacity and pressure ranges . . . then get in touch with Cooper-Bessemer.

Twin-Line pumps are built in 2, 4, 6, 8, 10, and 12 cylinder sizes for capacities from 10,000 to 70,000 barrels a day at pressures up to 2000 psi. A new bulletin tells all about these pumps, explains the above advantages and many others equally important. Send for the bulletin today.

These two 500 hp Cooper-Bessemer gas-Diesel engines, fueled by gas and crude from the Rocky Mountain area, are direct-connected through a fire wall to the two 10-cylinder Cooper-Bessemer Twin-Line pumps shown in the large photo.

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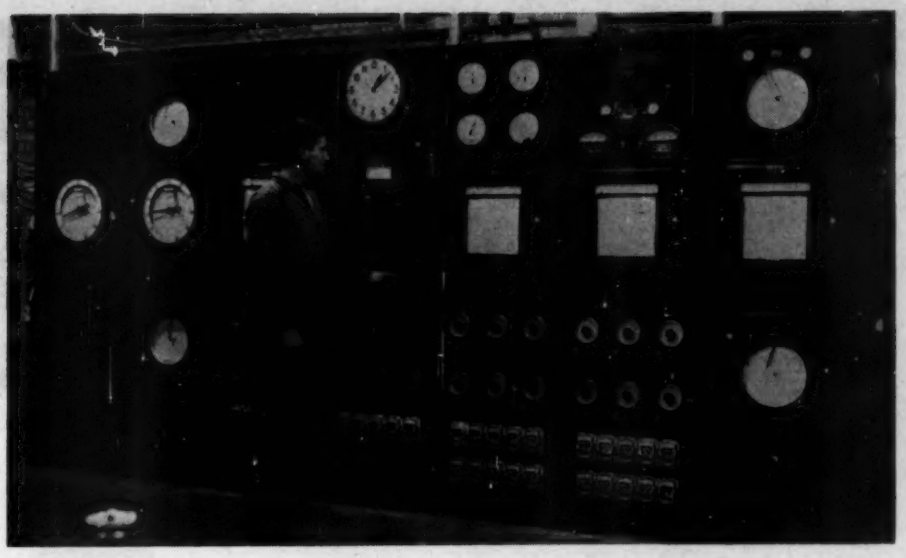
New Pilot Plant Fractionates Crude In One Operation



Instrument panel of UOP's crude distillation pilot plant.

Complete fractionation of crude oils and preparation of a variety of special feed stocks in a single operation can be accomplished by the use of a new pilot plant which has been installed by the engineers of Universal Products Company, and which recently was put into operation in Universal's Riverside Laboratories.

This new unit which operates at a crude oil rate of about a barrel an hour is completely equipped with automatic control devices and has replaced a number of smaller pilot plants in which distillation of crude oil and preparation of special feed stocks from various cuts was a lengthy step by step series of operations.

Evaluation of the potentialities of the refiner's crude oil is greatly simplified by the new unit and the cost is substantially reduced because the pilot plant can take a relatively small sample of the refiner's own crude oil and prepare samples of feed stock for various process units at a relatively low cost, whereas previously it has often been necessary to make an expensive full scale run in the refinery or in several pilot plants to produce the desired feed stock samples.

In Three Sections

The pilot plant consists of three more or less distinct sections which can be operated either separately or as one integral unit, the first section consisting of a gas-fired crude pipe still and fractionating column together with two side cut strippers in which are carried out ordinary crude oil fractionations at atmospheric pressure to produce gasoline, kerosine and light gas oil distillates leaving a residual reduced crude as crude column bottoms.

The second section of the unit consists of an electrically heated vacuum furnace and vacuum flash tower which can be used either to process crude column bottoms or extraneous topped crude. This section of the unit is equipped with a three-stage steam jet vacuum pump and barometric condensers which will permit operations at pressures substantially below those normally encountered in commercial vacuum flashing operations.

The third section of the unit consists of a superfractionating system of two highly efficient fractionators arranged for series operation, so that narrow boiling heart cuts can be prepared. It is frequently necessary to prepare such cuts for charge stock for specialized hydrocarbon conversion processes, such as hydroforming for example. The first of these two superfractionators can be operated in conjunction with the crude column to provide for continuous depropanization or debutanization of the straight-run gasoline from the crude oil.

The utility of the unit is easily demonstrated in a typical operation using the entire unit to prepare feed stocks and finished products from a crude oil. The crude oil is charged through the crude heater to the crude column and an overhead cut of unstabilized gasoline is removed.

Two Side Cuts Possible

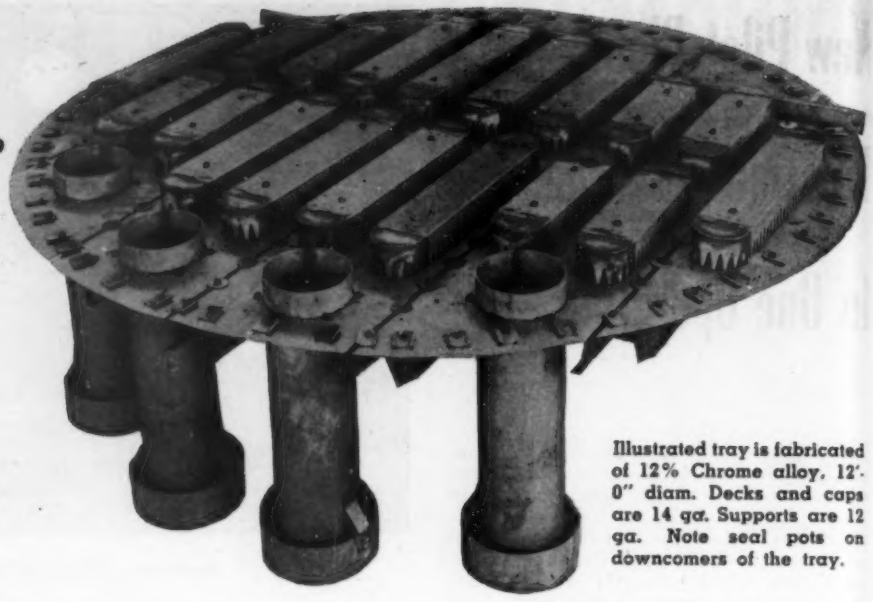
Two side cuts may also be taken if desired, and these cuts may consist of, for example, light naphtha and kerosine, or kerosine and light gas oil. The overhead product from the crude column may be stabilized in the primary superfractionator, and if further fractionation is required for some specialty product the stabilized product is fractionated in the secondary fractionator.

The crude tower bottoms are pumped to the flashing section heater where they may be processed at atmospheric or reduced pressure depending upon the depth of fractionation desired. The overhead product is normally used as feed stock for further pilot plant processing. The bottoms product is used as heavy fuel oil or for asphalt preparation.

The flashing section may also be arranged, using the heater for thermal reforming, to process a naphtha fraction for octane appreciation. Viscosity breaking of heavy crude oil fractions may also be carried out. The fractionation system may be used to process wide boiling range materials, for preparing special close boiling fraction products, either at atmospheric or reduced pressures.

The use of the two columns simultaneously permits taking as an overhead product a clean center cut. Other applications of the pilot plant as a whole or in part for feed preparation or processing can be made to meet specific problems without appreciable change to the unit.

Crude Distillation Pilot Plant, Universal Oil Products Company Laboratories.



Illustrated tray is fabricated of 12% Chrome alloy. 12'-0" diam. Decks and caps are 14 ga. Supports are 12 ga. Note seal pots on downcomers of the tray.

CORROSION

Corrosion allowance is not a factor when your trays are made of alloys. GLITSCH "Truss-Type" bubble trays and bubble caps have been fabricated from 18-8 stainless steel, 12% chrome, 17% chrome, Monel, Hastelloy, Everdur, copper and brass.

Bubble trays and bubble caps can be fabricated of metals and alloys that are suitable to withstand the degree and type of corrosion found in different zones in the tower. In many instances the lower chrome, less-expensive alloys are suitable for trays in the lower zones. The higher chrome-nickel alloys or other metals such as Monel, Everdur, Hastelloy, brass or copper, may be required in the higher zones.

Stay "on-stream" longer with GLITSCH light weight alloy bubble trays and bubble caps. (Where corrosion is not a factor, GLITSCH trays are fabricated of carbon steel.)

There is a conveniently located GLITSCH representative who will discuss either new or replacement trays and caps at any time . . . and without obligation on your part.

MANUFACTURED UNDER U. S. PATENT NO. 2,210,808; NO. 2,309,309; NO. 2,338,926; NO. 2,341,091 AND OTHER PATENTS PENDING.

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"TRUSS-TYPE" BUBBLE TRAYS ● BUBBLE CAPS ● TOWER INTERNALS

THE MONTH IN THE INDUSTRY

Petrol's Texas City Plant Now Operating

Petrol Terminal Corporation, with executive offices in Philadelphia, Pa., on December 13 placed in operation its refinery at Texas City, Texas. The plant, originally a part of the old Southport refinery, was purchased by Petrol from the War Assets Administration last September. According to E. M. Callis, president of Petrol Terminal, the refinery, which is still incomplete, was put into operation ahead of schedule in an effort to rush more fuel oil into the Philadelphia, Baltimore, and Washington areas.

Catalytic Construction Company, Philadelphia, was retained to recondition the plant. By mid-December reconstruction was far enough advanced to permit limited operation.

Present facilities permit the refinery to process 27,000 barrels of crude a day, with production confined to motor fuels, distillates and residual oils. One hundred-octane gasoline also will be produced when installation of a 54,000 barrels a day topping unit is completed. All work on the refinery is expected to be completed by July, 1948.

Competition of Shale Oil Said a Possibility

The extraction of liquid fuels from oil shale is progressing toward future active competition with crude oil, the recent rises of crude oil favoring this possibility.

William E. Warne, assistant secretary of the Department of Interior, in testifying recently before the House Appropriations Committee, said that experiments condcted by the Bureau of Mines in shale oil extraction at Rifle, Colo., indicated that shale oil may be produced at a cost of about $2 to $2.50 a barrel. The oil produced is equivalent to a low grade crude oil, as far as its evaluation as a refinery charge stock is concerned.

If further increases occur in the price of petroleum crudes, now selling at $2.65 a barrel in a large East Texas field, this possibility of competition from shale oil will, of course, be greater.

Co-op Dewaxing Unit

Installation of a methyl-ethyl-ketone dewaxing unit at its Coffeyville, Kan., refinery has been announced by Consumers Co-operative Association.

Howard A. Cowden, president, said the installation was expected to go into operation in 1949, cost of the installation being estimated at $1.5 million. Contracts were signed in mid-December. The unit will eventually replace the cold-acid treatment now being used.

Howard Kehde Now Heads Foster Wheeler Unit

Howard Kehde is now in charge of Foster Wheeler Corporation's process engineering of hypersorption units.

Kehde spent some four years with Union Oil Company of California in its process development division where he assisted Dr. Clyde Berg in development of all phases of the hypersorption process. He also assisted in the direction of the start-up operations of the first commercial hypersorption unit, which went on stream last May, and he hopes to present a paper soon on this operation to AIChE.

Kehde, a graduate of Columbia University, was employed by General Electric Company in the plastics division and in the synthetic phenol plant prior to his association with Union Oil.

Meetings

January, 1948
12-16—Society of Automotive Engineers, annual meeting, Detroit, Book-Cadillac Hotel.
30—NGAA Regional Meet, Corpus Christi, Texas, Driscoll Hotel.

February
2- 6—American Society of Heating and Ventilating Engineers, New York, Hotel Commodore.
15-19—American Society of Chemical Engineers, regional meeting, New Orleans.

March
1- 5—American Society for Testing Materials, committee week, spring meeting, Washington, D. C. Hotel Statler.
24-26—Natural Gasoline Association of America, annual convention, Ft. Worth, Texas Hotel.
24-26—API, Mid-Continent Spring Meet, Wichita, Kans., Broadview Hotel.

April
5- 7—Western Petroleum Refiners Association, annual meeting, Galveston, Galvez and Buccaneer Hotels.
5- 8—National Association of Corrosion Engineers, annual conference-exhibit, St. Louis, Jefferson Hotel.
14-16—API, Southwestern Spring Meet, San Antonio, Plaza Hotel.
19-20—Industrial Accident Prevention Associations, Annual Convention, Toronto, Royal York Hotel.
19-21—American Society of Lubrication Engineers, annual convention, Buffalo, Statler Hotel.
21-23—National Petroleum Association, Cleveland, Hotel Cleveland.
26-27—Independent Petroleum Association of America, Wichita Kans.
28-30—Liquefied Petroleum Gas Association, annual convention, Kansas City.

May
4- 5—American Gas Association, Natural Gas Department, Houston, Rice Hotel.
6- 7—API Pacific Coast Spring Meet, Los Angeles, Biltmore Hotel.
9-12—AIChE Regional Meet, Cleveland, Hollenden Hotel.
10-13—API Division of Refining Mid-Year Meet, Philadelphia, Benjamin Franklin Hotel.
15-22—International Petroleum Exposition, Tulsa.
24-26—American Gas Association, joint production and chemical conference, Asbury Park, N. J., Berkeley-Carteret Hotel.
31—Gas Technology Short Course, Texas A. & I., College, Kingsville.

June
7-11—Pittsburgh International Conference on Surface Reactions, Mellon Institute, Pittsburgh.
21-25—American Society for Testing Materials, annual meeting. Detroit, Book-Cadillac Hotel.

September
13-17—Third Instrument Conference and Exhibit, Philadelphia, Convention Hall.

Dr. Soday to Head Lion Oil Research

Lion Oil Company has named Dr. Frank J. Soday as director of research, in which capacity he will "conduct an expanded and intensified research program in all departments of the petrochemical field."

Dr. Soday

Dr. Soday for 15 years has specialized in the field of hydrocarbon utilization. During World War II he was technical director for Copolymer Corporation of Baton Rouge, La., and most recently he has been director of research for Devoe and Raynolds Company of Louisville, Kentucky.

Big Companies Aid School's Atomic Research Program

Westinghouse Electric Manufacturing Company and Aluminum Company of America have joined hands with the University of Chicago in a combined program of atomic research.

These two companies have joined with Standard Oil Company (Indiana) Standard Oil Development Company, Shell Oil Company and Sun Oil Company, in helping to finance peacetime atomic research as industrial members of the Institute for Nuclear Studies, Institute of Metals and the Institute of Radiobiology and Biophysics.

Westinghouse Electric is a member of all three institutes and the Aluminum Company of America has joined the Institute of Metals.

The three institutes comprise a $12 million research program recently launched by the University of Chicago.

Chancellor Robert M. Hutchins said that membership in the university's institutes is open to business organizations interested in keeping pace with atomic developments and in furthering research for industrial purposes.

Indiana Standard Workers Win Various Safety Awards

Employes of Standard Oil Company (Indiana) and subsidiaries won 24 of 34 safety certificates awarded in the oil industry by the American Petroleum Institute. Each cerificate recognized success in preventing accidents in a different branch of operations or location for a million or more man hours of work without loss of time or disabling injury.

Of 25 safety certificates awarded in the refining department Standard of Indiana received 16. Employes of the Whiting, Ind., refinery won nine certificates for the entire refinery or departments, Wood River, Ill., refinery employes received four for the entire refinery or departments, Casper, Wyo., and Sugar Creek, Mo., refinery employes won one each for the entire refinery, and the company manufacturing department

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received one for the entire department.

The award for the most man hours worked without disabling injury was won by all employes of the Whiting refinery with a record of 4,443,499 man hours. Next were all employes of the Standard of Indiana manufacturing department with 2,807,890 man hours, and all employes of the Wood River refinery with 2,160,185 man hours.

Stanolind Oil and Gas Company also recently received the Distinguished Service to Safety award of the National Safety Council. Standard Oil Company (Indiana), which received the same award for its Whiting refinery in 1945, and Stanolind Oil and Gas Company are among 12 oil companies that have been presented such wards by the National Safety council.

Texaco's Tulsa Workers Given Award for Safety

Double honors were awarded the West Tulsa Refinery, The Texas Company, last month in recognition of a record of operating over 1,253,000 man hours without a disabling accident.

The plant has operated over 785 days without a man losing time from his job because of injury.

D. J. Hoose, New York, manager, industrial relations, refining department of the company, presented to E. M. Reynolds, plant superintendent, the American Petroleum Institute's million man-hour certificate and the National Safety Council distinguished service award for safety and the NSC plant pennant.

Stanolind to Purchase Brownsville By-Products

Stanolind Oil and Gas Company and Carthage Hydrocol, Inc., last month announced that they had entered into a contract which provides for the purchase by Stanolind of all the chemical by-products (oxygenated chemicals) to be produced by Carthage at its synthesis gasoline plant under construction at Brownsville, Texas.

Stanolind also announced acquisition of a site for a chemical recovery and separation plant adjacent to the Carthage Hydrocol plant. Construction of Stanolind's plant will begin shortly.

The refined chemicals to be produced by Stanolind will consist of aliphatic alcohols, aldehydes, acids and ketons having basic use as solvents and as raw materials in many industries, such as those manufacturing rayons, plastics, surface coatings and pharmaceuticals.

Miller Named Director

Robert W. Miller, widely known California industrialist has been named to the board of directors of Standard Oil Company of California.

NGAA's First Regional Meeting In Amarillo Declared Huge Success

C. C. PRYOR, Associate Editor

The first regional meeting of the Natural Gasoline Association of America was held December 12 in the Herring Hotel, Amarillo, Texas. Attended by more than 250, the Panhandle Plains regional meeting, the first of two regional meetings scheduled by the association, was declared most successful.

F. M. Perry, Cities Service Oil Company, Bartlesville, Oklahoma, was chairman of the morning session of the one-day meeting, which was devoted to technical papers of special interest to natural gasoline industry men of the area. Introductory remarks, "Keeping Posted" were made by C. R. Williams, The Chicago Corporation, Corpus Christi, president of the NGAA. Williams, in discussing the regional meetings, pointed out that one of the reasons for such meetings was to bring the increased activities of the association to the natural gasoline industry in various areas, and to aid in greater participation of the members in the efforts of the association.

P. C. Keith on Program

P. C. Keith, of Hydrocarbon Research, Inc., New York, will address NGAA members on "Carthage Hydrocol" at the Corpus Christi regional meeting Friday, January 30, according to the tentative program released by James Doughty, program committee chairman. The meeting will be held at the Driscoll Hotel.

Other papers include "Fundamentals of Fractionation" by A. J. L. Hutchinson, Fish Engineering Corporation, Houston; "Engine Maintenance" by Earl Martin, The Cooper-Bessemer Corporation, Corpus Christi; 'Trading Information" by C. R. Williams (NGAA President), The Chicago Corporation, and "Technique of Capping Wild Wells" a movie by the Kinley Brothers. Authors of two papers have not yet been announced.

Members of the program committee are Roy Schuster, The Chicago Corporation; Wendell van Hook, Stanolind Oil & Gas Corporation; J. C. Birdsall, Lockhart Oil Company, and Frank H. Stone, La Gloria Corporation.

J. C. Hutcheson, Shell Oil Company, Inc., Great Bend, Kans., presented the first paper of the meeting, on "Gasoline Plant Process Water Treatment." Hutcheson's paper dealt with methods for improving operating conditions in plants using older water treating equipment and the use of available water treating chemicals. He discussed the training of plant personnel in the methods of water treating to be used and the tests necessary to control the treatments. Hutcheson described treating and testing methods for water for boiler makeup cooling towers, and engines. He presented case histories of water treating at several plants in the Panhandle area.

In a prepared discussion of Hutcheson's paper, J. S. Connors, Phillips Petroleum Company, Borger, Texas, gave additional material on the theory, application, and operating data of water treating for gasoline plants. He listed three methods of water treatment for boilers and some of their variations, and discussed the advantages and disadvantages of each method. In case histories of several Panhandle plants, Connors cited the methods and results obtained with some of the methods described. Methods for calculating the tendency of the water to dissolve or precipitate calcium carbonate, or scale or corrode were outlined as were the modifications of the Langlier method by Larson and Buswell, for determining the pH of water, and Ryznar for the stability of recirculated waters.

In "Maintenance and Operation of Plug Valves," Roy H. Bush, Nordstrom Valve Division, Rockwell Manufacturing Company, Tulsa, reviewed briefly the historical background and development of plug valves, described the three types of valves—standard, intermediate, and high pressure—and discussed their application and maintenance. He emphasized the importance of lubrication and proper methods of packing gland installation in plug valves, and presented a list of nine hints to provide longer maintenance-free operation.

J. A. Craig, Skelly Oil Company, Skellytown, Texas, spoke on "Plant Operations for Maximum Recovery of LPG." He discussed the factors that should be considered in attempting to increase LPG production in existing gasoline plants, and the methods currently in use for optimum LPG recovery. (This article appears in this issue of THE REFINER along with discussion by B. O. Bentley, Hagy, Harrington, and Marsh, White Deer, Texas.

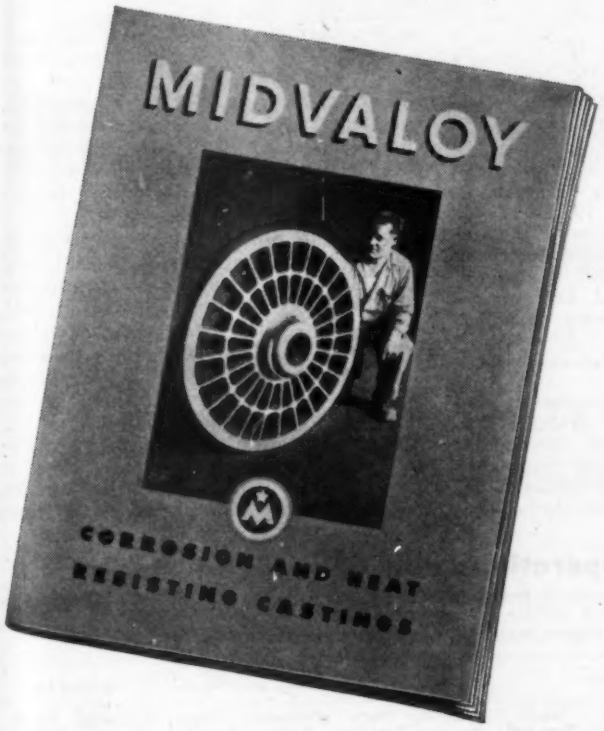
The afternoon papers were of general interest to the natural gasoline industry and related industries. Chairman was B. R. Carney, The Shamrock Oil and Gas Corporation, Amarillo.

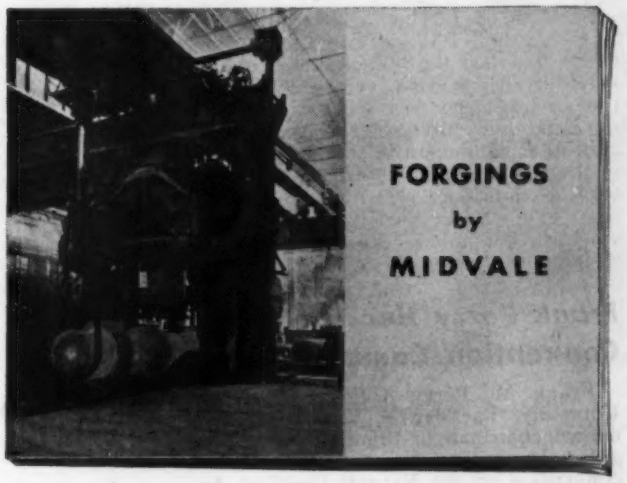
L. R. Hagy, mayor of Amarillo, stated that the recent price increases of gasoline has brought the natural gasoline industry up to a comparative basis with other industries. The natural gasoline industry, he said, has done a good job of expanding. He suggested that the industry encourage research and technical progress and told how the people of the world depend on gasoline. He discussed briefly the detrimental effects of government red tape on the industry.

"Carbon Black in the Texas Panhandle" was discussed by Ira Williams, J. M. Huber Corporation, Borger. The Panhandle, Williams told the group, has a large carbon black industry because it has been the only locality which, under the law, could supply sufficient natural gas. Although the gas used at first was considered distress gas, carbon was produced not to utilize excess gas, but because of the great demand for carbon

ALL ABOUT FORGINGS, STAINLESS CASTINGS, TOOL STEELS

Midvale's three new descriptive catalogs on Forgings, Stainless Castings and Tool Steels are required reading for 1948. The best way to start the New Year—ask for copies of the catalogs which will interest you. They are new, complete, full of up-to-date information on *custom steels.*





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black for tires, inks, and other products. Carbon black is at present the most satisfactory material of its type for use in compounding of rubber for automobile tires. Williams cited statistics to indicate the size of the rapidly growing carbon black industry. County, state, and school taxes amounted to $211,187, gross production taxes to $1,426,000, and the industry's payroll to $6,799,000. Revenue from the sale of gas to carbon companies is at an annual rate of about $11,342,000, which is approximately the same as the revenue from the sale of gas for light and fuel uses.

Col. E. O. Thompson, chairman of the Texas Railroad Commission, in his paper, "Progress of the Panhandle Gas Field," said that the time may not be far off when chemical industries, based on Panhandle natural gas, will join with carbon black, inter-state pipe lines and the manufacture of petroleum products in creating a true industrial empire on the high plains.

"Metal reduction, the generation of electrical power, synthetic rubber and the synthesis of ammonia are beginning to be important in the demand for natural gas in the Panhandle," he declared as he pointed out that in the case of both gas and liquids, reasonable prices and demand are the best incentives for conservation.

One of the highlights was an interview with J. J. Hastings (retired) by S. C. Carney, Phillips Petroleum Company, Bartlesville, Oklahoma, entitled "How It All Started." Hastings related the story of the first gasoline plant to the group, describing the first absorbers and other equipment in stripping the gas of liquids to prevent freezing in gas transmission lines. He also described the first gas compressors with which he worked. A number of pictures of early installations were shown.

Frank Perry Heads NGAA Convention Committee

Frank M. Perry, Cities Service Oil Company, Bartlesville, Okla., has been named chairman of the convention program committee for the 27th annual convention of the Natural Gasoline Association of America, scheduled for March 24-26 at the Texas Hotel, Ft. Worth.

Other members of the committee are Henry M. Brown, Midland Gasoline Company, Houston; J. H. Dunn, The Shamrock Oil and Gas Corporation, Amarillo; T. R. Goebel, Shell Oil Company, Inc., Houston; J. A. LaFortune, Warren Petroleum Corporation, Tulsa; John F. Lynch, LaGloria Corporation, Corpus Christi; Albert H. Weil, United Gas Pipe Line Company, Shreveport.

NGAA President C. R. Williams pointed out that the meeting is being held earlier than ever before to avoid conflicts with other oil meetings. The theme, of the sessions will be better utilization and conservation of hydrocarbons—ways to avoid losses of the volatile products manufactured at natural gasoline and cycling plants after they leave the plant.

Studies are already being made of transportation losses and the losses at filling stations as well as the waste from automobile tanks and fuel systems. Reports of these studies will show that most of these losses can be eliminated thus adding considerable volume to the motor fuel supply, Williams declared.

Minckler

Dickey

Minckler Succeeds Dickey as Head of General Petroleum

R. L. Minckler has been elected president of General Petroleum Corporation, Los Angeles, succeeding, on January 1, S. J. Dickey, who is retiring. R. A. Sperry, senior vice president and a director of the concern, also retired on that date.

Minckler was elected a GP vice president in 1945, upón returning from wartime service as PAW's director of petroleum supply. In June of this year he was advanced to the position of executive vice president.

Minckler joined General Petroleum in 1924; became assistant to the president 10 years later and in 1941 was elected a director.

Dickey, whom he succeeds, has been president of General Petroleum since 1941. He first joined the company in 1919, was made chief engineer in 1920, a director in 1927 and vice president in charge of manufacture in 1930.

Sperry is one of the pioneers of General Petroleum, having started work in the Kern River fields in 1901. He joined General Petroleum in 1912, becoming a director in 1925, and a vice president in 1926.

Compact Committee Warns Against Further Controls

Continuation of maximum supply efforts, together with excellent co-ordination, should make it possible to meet the anticipated increase in (oil) demand for 1948 if everything works out favorably, although difficult supply problems for the next few months will continue to cause temporary trouble in local areas. This was the opinion advanced by the economics committee of the Interstate Oil Compact Commission at the Commissions quarterly meeting held in mid-December in Oklahoma City.

The 1948 demand for petroleum products will be 6 percent higher than the demand in 1947 and crude runs to refinery stills of 5,375,000 barrels daily will be required, the committee estimated.

Improvement was noted in the Midwest but delay by the government in placing inactive tankers in service for supplying the East Coast will make the already difficult situation much worse.

Midwestern stocks were higher at the end of October than a year ago but the report cautioned that the improvement did not correct all local supply difficulties.

The first quarter demands of 1948 "will result in a heavy drain on products stocks and will probably mean some distribution difficulties," the report continues. "It will take tremendous effort, excellent co-ordination and favorable conditions generally to attain the necessary yields and to transport and distribute supplies so as to minimize temporary local difficulties."

Assuming normal weather, the January-February-March demand will total 6,295,000 barrels per day as compared with 5,917,000 barrels per day in 1947.

"The operation of normal economic forces has been so effective in expanding supplies this year (1947) that it seems wise to rely on the same forces for the future in balancing supply and demand," the committee stated. "Methods successful to date are most likely to succeed in providing further increases in supplies.

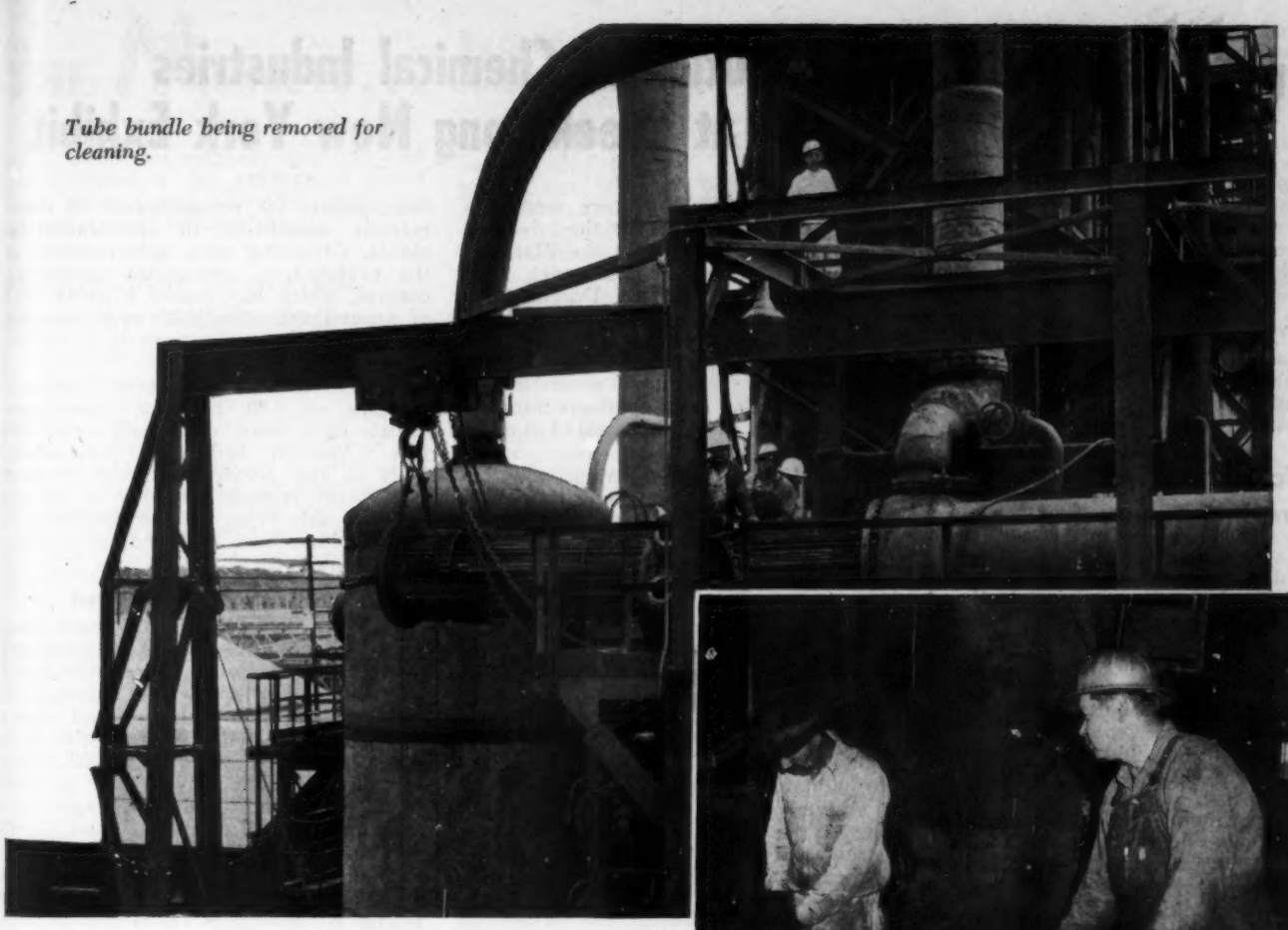
"Any further controls and regulations

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1946:									
January 26	4,626	4,553	220,544	13,622	101,737	5,720	29,498	8,411	39,722
March 2	4,726	4,779	229,430	13,871	104,462	5,888	25,148	8,634	38,441
March 30	4,425	4,684	224,994	13,896	104,715	5,337	28,240	8,738	37,746
April 27	4,672	4,685	224,443	14,228	99,631	5,568	30,466	9,204	39,404
May 25	4,759	4,857	222,214	14,322	95,769	5,463	32,973	8,908	43,368
June 29	4,957	4,854	223,883	14,500	92,333	5,325	37,762	8,828	46,447
July 27	4,926	4,896	223,756	14,535	88,626	5,817	44,316	8,217	49,517
August 31	4,833	4,901	225,672	15,405	86,813	5,374	53,858	8,357	53,037
September 28	4,778	4,829	221,903	14,538	85,854	5,450	57,903	8,158	56,914
October 26	4,730	4,758	221,184	14,863	84,623	5,710	65,449	7,728	60,872
November 30	4,795	4,707	225,119	15,145	88,371	5,228	66,062	6,672	58,647
December 28	4,713	4,968	226,111	15,604	93,126	5,931	58,941	8,181	53,427
1947:									
January 25	4,672	4,820	221,655	14,624	99,801	5,630	50,357	8,224	48,558
February 22	4,786	4,860	224,580	14,668	103,904	5,929	40,739	8,532	44,919
March 29	4,865	4,843	225,720	14,396	107,576	5,969	32,737	8,668	43,364
April 26	4,930	4,725	234,051	14,213	103,860	5,435	32,286	8,186	42,668
May 31	5,024	5,000	239,370	14,709	95,876	5,732	36,032	8,910	45,224
June 28	5,109	5,093	236,221	16,070	91,806	5,606	41,721	8,298	48,490
July 26	5,084	5,162	231,357	16,142	85,812	5,708	47,097	8,738	52,497
August 30	5,157	5,209	228,281	16,753	84,105	5,919	54,808	8,962	55,243
September 27	5,196	5,290	224,994	16,501	82,472	6,136	60,406	8,580	56,777
October 25	5,295	5,165	224,308	16,529	82,003	6,638	62,609	8,666	57,419
November 29	5,257	5,309	224,540	16,667	86,319	6,382	61,988	8,405	56,747
December 27	5,285	5,543	222,770	17,013	91,269	7,041	50,324	9,698	51,896



Tube bundle being removed for cleaning.

Retubing heat exchanger with Anaconda Arsenical Admiralty Tubes at Shell Oil Company's Deer Park Refinery.

SHELL OIL RE-TUBES WITH *Anaconda* ARSENICAL ADMIRALTY *in all-hydrocarbon heat exchanger*

IN THE Houston, Texas, refinery of the Shell Oil Company, copper alloy tubes are ordinarily used for water service in condensers and coolers.

But when ferrous tubes failed in the heat exchange between topping vapors and debutanizer charge, the bundle was retubed with Anaconda Arsenical Admiralty "439", ¾" O.D., .083" gage.

In this particular equipment, stripping steam and hydrogen sulfide in the column vapors are partially condensed in the exchanger creating an acid condition which attacked the original tubes. After two and a half years of service the Anaconda Arsenical Admiralty Tubes continue to give satisfactory performance.

Arsenical Admiralty "439" is but one of 10 standard and several special condenser tube alloys currently produced by The American Brass Company. The broad metallurgical knowledge and practical experience of our Technical Department are at your service in helping you make the right selection. Write for Anaconda Publication B-2. 47180

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THE MONTH...

would interfere with operation of the economic forces which have been so successful in stimulating the industry to its amazing achievements."

Governor Beauford Jester of Texas was elected chairman of the Interstate Oil Compact Commission succeeding Hiram M. Dow of New Mexico.

E. Leland Richardson of Louisiana was named first vice chairman, Don T. Andrus of Pennsylvania, second vice chairman, and Earl Foster, executive secretary.

Solliday and Rouse Get Stanolind Promotions

A. L. Solliday, director and vice president in charge of operations of Stanolind Oil and Gas Company, Tulsa headquarters, has been elected executive vice president and J. E. Rouse, director in charge of manufacturing and producing operations, elected to succeed Solliday as operating vice president.

Solliday, a 1923 geology graduate of the University of Oklahoma, was first with Dixie Oil Company and when Stanolind was organized in 1931 he became superintendent of the land department. He has been a director and vice president in charge of operations since 1944.

Rouse got his M.E. degree from Brown University in 1913 and went to work immediately for Standard Oil Company of New Jersey at Bayonne. He joined Midwest Refining Company in 1918 and when that company was purchased by Standard Oil Company (Indiana) in 1921, he was promoted to assistant superintendent of the Casper refinery. Ten years later he was in charge of all refineries in the Rocky Mountain division. He became assistant general manager of manufacturing for Indiana Standard in 1933, stayed on that job for 10 years, did considerable war work for PAW and the Navy, joined Stanolind in November, 1945 as manager of the manufacturing department and a year ago was elected director in charge of manufacturing and producing operations.

Texaco Jet Propulsion Fuel Project Under Way

The Texas Company's laboratory at Beacon, N. Y., for study of new fuels for jet propulsion engines is slated to open this month.

While primarily interested in the manufacturing of fuels from petroleum, experiments with special inorganic materials are being conducted.

The Texas Company expects to ship within the next two months its first cargo of special kerosine to be used as jet fuel. Designation of the buyer was not disclosed.

Creole Names Smith

L. G. Smith, vice president in charge of refining activities, has been elected a member of the board of directors of Creole Petroleum Corporation.

The company also announced the resignations from the Board of W. J. Haley and W. R. Goodwin.

Contribution of Chemical Industries Shown at Week-Long New York Exhibit

More than 50,000 visitors were impressed and stimulated by the advances disclosed by exhibitors at the 21st Exposition of Chemical Industries. The exposition, which closed December 6, after a week's run in Grand Central Palace, in New York, was the greatest ever held. How the chemical industries are reaching forward to contribute to better living and more comforts throughout the world was demonstrated in many ways.

Keeping pace with the rapid adoption of research results has come the development of suitable equipment to process the new formulations. The chemical engineer, in a stiff race with the chemist has outdone any performance of prewar years evolving new equipment to translate laboratory conclusions into terms of safe and economical production plants and equipment therefore. Many of the new formulas that are in the news of the affected industries today have been made commercially possible only because new processing equipment was brought along, step by step with them.

A vital adjunct to chemical engineering is the highly technical field of instrumentation, on which the laboratory is heavily dependent for better research tools, and which provides the essential counterparts for measurement of commercial quantities in manufacturing plants. Crowning such achievements is the evolution of automatic processing control, which has gained a great deal of ground since the last exposition and is finding new applications in a widening list of industries.

At one booth there were displayed samples of 550 chemical substances which have been developed since the last Chemical Industries Exposition. This is the greatest number of new items ever brought together in an exhibit of this type, though similar collections have been gathered for a number of previous shows.

Plastics Well Represented

Perhaps the most rapidly expanding group of materials is the plastics and synthetic resins, which were represented in a number of ways.

The evolution of plastics and resins proceeds at a bewildering rate with such new products exhibited by the manufacturer of the basic polyethylene as nonbreakable bottles, used in packaging hydroflouric acid, cosmetics and toilet goods.

A manufacturer of corrosion-resistant materials has developed a new kind of piping consisting of fused quartz protected and reinforced with acid resistant, high temperature laminated plastic armor. Available now in all sizes, with valves, fittings and auxiliary equipment, this new material will be in full production in 1948.

Marked throughout the processing industries is the tendency to step up the potentials, such as pressures, temperatures and velocities. In line with this trend a manufacturer of processing equipment has produced a centrifuge which develops a centrifugal force equal to 6400 times gravity, enabling it to effect extremely efficient separation even when there is but a slight difference in the specific gravity of a mixture's components.

One exhibit concentrated exclusively on single-stage and compound vacuum pumps, vacuum-tight valves and vacuum gages. In the same field was a rotary high-vacuum fractionating still, operating on a new principle which permits fractionation at high vacuum, and so opens new opportunities to the chemical industries.

The exposition was held under the management of the International Exposition Company, Charles F. Roth, president, was manager of the exposition and E. K. Stevens, associate manager.

Pan Am Purchases Root, Many Officers Retained

Purchase of a majority of the stock of Root Petroleum company by Pan American Petroleum Corporation was announced December 17 by D. P. Hamilton, president of Root, and Bruce K. Brown, president of Pan Am.

Root Petroleum company's principal office is at Shreveport, La., and its major property is a modern refinery at El Dorado, Ark., which runs 20,000 barrels per day of crude oil, operates a fluid catalytic cracking unit, and produces gasoline and a full line of other petroleum products. During the war Root was a prominent producer of 100 octane aviation gasoline.

Hamilton participated in the organization of Root a quarter century ago and has for many years been its president and principal stockholder. He will continue as a director of the company.

The new president of Root will be Dwight F. Benton, who will resign his position as general manager of the lubricating and sales technical service departments of Standard Oil Company (Indiana). Horace Canon, who has been executive vice president and a director of Root, will continue to serve in that capacity, as will the other officers and department heads.

Pan Am is a subsidiary of Standard Oil Company (Indiana) and has its principal office at New Orleans. It operates a refinery at Destrehan, La. Bruce K. Brown, president of Pan Am, also is a vice president of Standard Oil Company (Indiana). A. A. Corona of New York and J. B. Hamblen of New Orleans are, respectively, vice president and general manager in charge of manufacturing.

Phillips Subsidiary Gets Montana Refinery

Capital stock of Home Oil & Refining Company and A. B. Cobb & Company has been sold to Wasatch Oil Company of Salt Lake City, and Ada Oil Co., Houston, with control of the two corporations to be held by Wasatch Oil, a subsidiary of Phillips Petroleum Company.

Home Oil & Refining Company and

THE MONTH . . .

A. B. Cobb & Company, together, own a 2500-barrel a day refinery at Great Falls, Mont., and also 200 producing oil wells in the same state.

Socony Gets Crude Oil From the Middle East

Socony-Vacuum Oil Company, Inc., on December 19, received its third tanker cargo of crude oil from the Middle East at its Paulsboro, N. J., refinery. The tanker docked with 21,934 tons of crude oil (166,449 barrels) after leaving Ras Tanura on the Persian Gulf in Saudi Arabia on November 24.

A fourth tanker with another 15,000 tons of crude oil for Socony-Vacuum left Ras Tanura on December 22 and is to arrive about January 18.

Public Relations Group Pushing Oil Conservation

A concentrated campaign to gain the cooperation of the American public in the conservation of petroleum products and to obtain better understanding of the oil industry's efforts to meet the current unprecedented demand, was decided upon last month by the public relations operating committee of the American Petroleum Institute.

"The "more intensified program" which aims at gaining public cooperation "in order that there will be sufficient supplies for all needs" will be directed by a special subcommittee headed by W. R. Huber of Gulf Oil Corporation, Pittsburgh. Other members are Ralph Champlin of Ethyl Corporation, New York; Conger Reynolds of Standard Oil Company (Indiana), Chicago; Richard Rollins of The Atlantic Refining Company, Philadelphia; and H. L. Curtis, Shell Oil Company, New York.

The entire public relations operating committee will meet in Boston January 15, when election of a chairman is scheduled.

ISAP Council

The fifth reunion of the International Permanent Council of the South American Institute of Petroleum (ISAP), that is scheduled to convene annually in South American capitals, will be held in Montevideo. The Council will occupy itself principally with preparations for the First South American Congress of Petroleum which will be held in Lima in March, 1949. The Congress was to have been held in 1948 but was postponed because of the International Petroleum Exposition slated for Tulsa in May, 1948, a statement sets out. ISAP announces it will participate in the latter and will send numerous delegates.

Fire Damage at Oleum

Fire late in December damaged Union Oil Company's gasoline refinery at Oleum, Calif. A 50-foot vacuum distilling tower was damaged extensively and two 70-foot towers burned superficially. Manager G. H. Hennan said that no loss in production would result.

A line rupture in the thermal cracking unit manufacturing gasoline was blamed.

Bogert Joins Evans Research And Development Corp.

Marston Taylor Bogert, emeritus professor of chemistry at Columbia University, and former president of the American Chemical Society, has been appointed senior scientific advisor of Evans Research and Development Corporation, New York. Bogert is a world authority on synthetic organic chemistry.

Dr. Bogert

Colonel Bogert, a past president and honorary member of the American Chemical Society, of the Society of Chemical Industry, and of the Chemists' Club; a past president of the International Union of Chemistry and still a member of its governing Bureau, belongs to many other professional groups and is a recipient of medals and decorations as follows: Nichols, Priestley, Egleston, American Institute of Chemists, Charles University (Prague), Comensky University (Bratislava), and Commander of the Order of the White Lion (Czechoslovakia).

During World War I he served as acting director of the Chemical Warfare Service and a member of the War Industries Board. He was a colonel in the U. S. Army. During World War II he was a member of the Chemical Referee Board of the War Production Board.

Engineers to Sponsor Schools in Key Cities

A series of "universities" in key American cities for graduate engineers, staffed by practicing members of the profession, has been outlined by The American Society of Mechanical Engineers. The pilot operation of the "university" is already under way in Detroit, and several other cities are initiating similar programs.

"This plan has been devised, not as a criticism of present engineering schools, but as a new aid to the engineer just out of college and starting his professional practice," Eugene W. O'Brien of Atlanta, president of the ASME, said.

The Engineers' Council for Professional Development, a national organization, is sponsor of the plan. Under its chairman, James W. Parker of Detroit, it will work in that city to give courses, lectures and consultations to engineer graduates. "Regents" of the new university will be past presidents of the society, and the faculty will be outstanding engineers in active duty in the area.

Tests of high school students down to the tenth grade to measure engineering aptitude or its lack also were commended by O'Brien as another phase of the Engineers' Council program.

Hankins Succeeds Cooper At Cabin Creek Refinery

David P. Hankins, of East Bank, became superintendent of The Pure Oil Company's Cabin Creek, West Va., refinery on January 1, J. Porter Langfitt, vice president in charge of refining announced.

In his new post Hankins will succeed C. W. Cooper, superintendent since June, 1945, who is being transferred to the company's Chicago office where he will have special assignments in the company's refining division. Hankins has been with Pure Oil for 23 years, and at Cabin Creek for 12 years.

Harold P. Sanders, Pure Oil employee since 1929, became assistant superintendent of the Cabin Creek refinery.

Monsanto Personnel Changes for the Month

Monsanto Chemical Company during December announced the following changes in personnel:

Howard A. Marple to be director of the company's newly created advertising department. With the company since 1937, Marple served as editor of Monsanto Magazine for many years. (R. Allan Gardner of St. Louis was appointed assistant director.)

Richard O. Zerbe, named director of the newly created development department at Monsanto's Nitro, W. Va., plant.

James P. Mahoney transferred from the company's Merrimac Division at Everett, Mass., to the organic division sales office where he will be in charge of Merrimac Division sales and sales development.

Edwin L. Hobson appointed sales manager of thermoplastic molding materials replacing Arnold C. Martinelli, resigned to become general manager of Rogers Plastics, Inc., North Wilbraham, Mass. James P. Skehan, now sales manager for sheet plastics will replace Hobson as assistant branch manager, New York plastics office.

Claiborne L. Barber transferred from sales contacts in the St. Louis area to the organic division sales office in Houston, and Howard I. Armstrong transferred from the St. Louis area to the company's Merrimac Division at Everett, Mass. Armin L. Klemm will replace Barber in St. Louis and Armstrong will be succeeded by Rogers W. Malone, Jr.

Rogers C. Sonnemann appointed industrial relations director for the Everett, Mass., plant.

Diesel Engine Survey

Completion of a survey to establish the amount of diesel engine horsepower in each state and an estimate of the increase of horsepower in the nation during the next five years, is anticipated early in 1948. The survey is being made by Diesel Engine Manufacturers Association.

Harvey T. Hill, executive director of the association, said the purpose of the survey was to aid oil men in meeting the demand for diesel fuels. The survey will include a breakdown of the types of engines. The survey is the first since 1939.

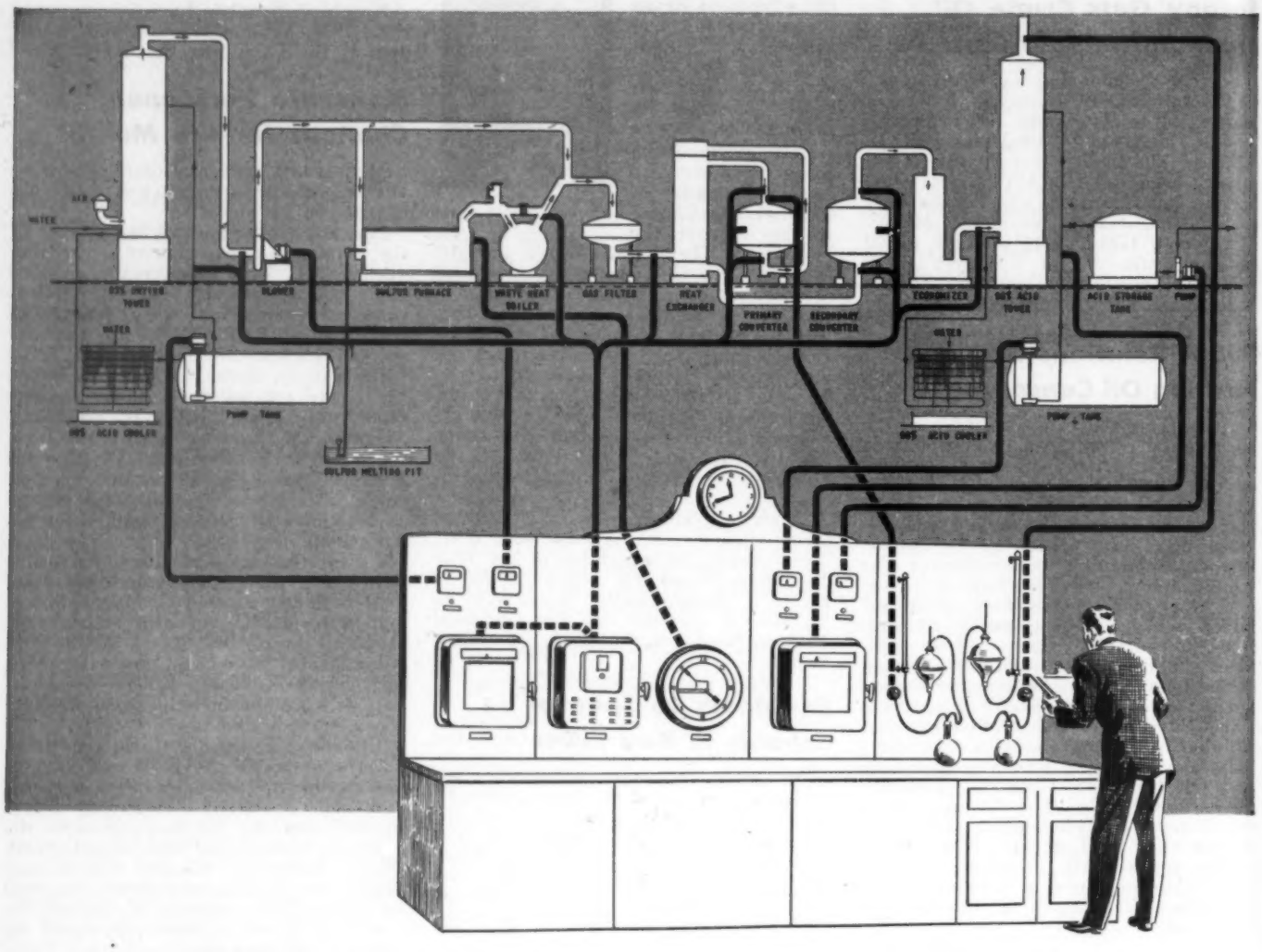
Asphalt Institute Elects

A. M. Maxwell, vice president of Standard Oil Company (Ohio) has been named president of the Asphalt Institute. He also was elected chairman of the executive committee.

Other officers include Bernard E. Gray, re-elected general manager and chief engineer of the Institute; Herbert

It Takes One Man

TO OPERATE A CHEMICO ACID PLANT



Operating costs of Chemico plants are low . . . and here is one reason: CONSERVATION OF MANPOWER.

For 34 years Chemico engineers have been developing methods of controlling and checking plant performance from a central location. The need for operating personnel has been reduced in some cases to the irreducible minimum of ONE MAN.

In Chemico-built contact acid plants for example, this one man can keep watch on a group of instruments which continuously report performance of the entire plant . . . make SO_2 gas analyses and efficiency calculations . . . and keep the plant in perfect operation UNASSISTED.

Such efficiency is not developed overnight.

It is the result of experience gained in building hundreds of heavy chemical plants. This priceless asset is perhaps the major reason why you should commission Chemico to design and build your heavy chemical plants.

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"Chemico plants are profitable investments"

OO-140

Spencer, Witco Chemical Company, secretary; F. V. Sidger, Witco Chemical Company, treasurer; John N. Smith, Socony-Vacuum Oil Company, assistant treasurer.

Five regional vice presidents are Atlantic and Gulf Coast division, Wallace D. Craig of Standard Oil Company (New Jersey); Ohio and Great Lakes, D. N. Meyers, Byerlite Corporation; Midwest, L. W. Lee, Husky Refining Company; Southwest, Harold J. Buck, Talco Asphalt and Refining Division of American Liberty Oil Company; Pacific Coast, N. H. Angell, Standard Oil Company of California.

Sunray Finishes Topping Plant in Record Time

Sunray Oil Corporation has completed remodeling the former Associated Refineries' gasoline plant at Duncan, Okla., the 18,000-barrel topping unit going on stream in early December just 77 days after work of remodeling was started. The unit will produce gasoline, distillate, gasoils, and fuel oils from crude received from the Velma Field through a new 6-inch pipe line.

Contracts are being let by Sunray to build six 80,000-barrel storage tanks to augment crude and production storage.

The catalytic cracking unit on which engineers are working is scheduled to be completed early this year. Gas oil from the topping unit will provide a part of the charge stock to the cracking unit.

New Gasoline Plant Listed for Oklahoma

A gasoline plant capable of processing 85 million cubic feet of gas daily will be constructed near Maysville, Okla., a joint project of Warren Petroleum Corporation, Carter Oil Company, Cities Service Oil Company, and Sinclair Prairie Oil Company. Dresser Engineering Company of Tulsa is contractor on the project under the supervision of Warren Petroleum Corporation. Warren will operate the plant. Completion is scheduled within the next twelve months.

New Synthetic Rubbers

Two new types of synthetic rubber, Philprene A, which the manufacturers, Phillips Petroleum Company, claim is superior for tire treads to natural rubber as well as to the synthetic rubbers now being produced, and Philprene B, which promises to be a replacement for natural rubber in tire carcasses, are being produced on pilot plant scale. The new rubber is a butadiene-styrene copolymer and is manufactured in water emulsions at temperatures considerably lower than used in making present-day synthetic rubber.

Philprene B, like Philprene A, is a butadiene-styrene copolymer, but its chief advantages are high tensile strength, resistance to cracking, and low heat build-up.

Estimated plant production costs of Philprene A are approximately the same as for regular GR-S type of synthetic rubber. Philprene B costs are expected to be only slightly higher.

Continued LPG Gains Foreseen

During the past year the sales of liquefied petroleum gas gained 30 percent over the 1946 sales and prospects are good for continued gains during 1948, according to a report issued by R. W. Thomas, manager of the Research and Development department, and K. W. Rugh, manager of the Sales department, Philgas Division of Phillips Petroleum Company. The report in part follows:

"The liquefied petroleum gas industry continues its rapid growth. Within the past three years the total sales of the industry have more than doubled, reaching an estimated total volume in 1947 of 1845 million gallons. The estimated increase in volume sold in 1947 over 1946 is almost equal to the total volume sold in 1941, the last year of normal activity preceding World War II. Liquefied petroleum gas in all of its uses is experiencing a greater and more widespread demand and acceptance than previously.

"By no means was the market demand for liquefied petroleum gas satisfied during the past year. The volume sold was limited by a combination of several factors, such as insufficient production of appliances and utilization equipment, shortage in transportation facilities, and inability to obtain necessary materials to construct additional facilities for production of liquefied petroleum gases. A large unfilled demand for these products continues to exist and can not be fully satisfied until these shortages are met.

There has been considerable unfilled demand for new industrial installations. The inability of the industry to supply LPG to many prospective users has limited the number of new industrial LPG installations. Some increase in consumption of LPG in existing industrial installations has taken place, however, most of these manufacturers have long been operating at near capacity hence the opportunity was not great for increased gas sales during the past year to these existing installations.

Chemical Uses Continue to Grow

The use of LPG by the chemical industry continues to increase principally for conversion to chemical intermediates. To guarantee obtaining these raw materials now chemical plants are locating adjacent to the points of production of LPG. This has resulted in much LPG being delivered either in the liquid or gas phase by pipe line from the points of production to the chemical plants. It is estimated that 415,000,000 gallons were consumed by the chemical industry in 1947. This represented an increase over 1946 of 34.9 percent.

There is a huge potential supply of propane existing in gas streams but unrecovered at the present time. To segregate any significant volume of this potential supply requires much additional equipment costing considerably more than the extraction facilities which have heretofore been installed. In the case of propane obtained from natural gas sources, increased quantities are being secured generally by expensively increasing the recovery efficiencies of the extraction units to obtain a greater percentage of the propane available in the streams being processed. Frequently the added investment per gallon is as much as three times the amount invested in the past for facilities designed for lower recoveries. In the case of material secured from refineries it is usually necessary to first replace the extracted material with fuel oil or natural gas since the unextracted LP-Gases are generally consumed as fuel at the refineries. It is necessary generally for the refinery to install new extraction and purification equipment in order to produce specification products.

The increased cost of additional production facilities today is magnified by the rising costs in both material and labor. All these factors have contributed materially to the increased cost of propane. Butane has been rather completely recovered at most plants for years.

Engineers On Hand for French Refinery Work

Subsequent to the action of the French government in licensing the rebuilding of the refinery of the Raffineries de Petrole de la Gironde at Bec d'Ambes, near Bordeaux, France, steps have been taken to speed the engineering and construction. The refinery's 8000-barrel per day production facilities have been out of operation since war bombings.

The new plant will have a capacity of 14,000 barrels per day of gasoline, kerosine, diesel and fuel oils, facilities including thermal reforming and chemical treating.

Engineers of Arthur McKee and Company will be in charge of the construction and work will start soon.

Wilson Is Promoted by Ohio Standard Company

J. Frank Wilson last month was named vice president of Standard Oil Company (Ohio) in charge of crude oil purchasing. Wilson, who joined the Sohio organization in 1935, is president of the Ohio River Pipe Line Company, vice president of Owensboro-Ashland Company, vice president of Columbia Pipe Line Company, vice president of Sohio Pipe Line Company and a director of Atlas Oil and Refining Company.

Nelson Promoted

In line with Stanolind Oil and Gas Company's expansion and decentralization program, R. E. Nelson, Jr., became division manager of the Texas-Louisiana Gulf Coast division January 1.

Nelson who will be in charge of all operations will maintain headquarters in Houston. For about a year he has been executive assistant to the director of producing and manufacturing.

Gets Fellowship

Jim L. Huitt recently was appointed to the Aluminum Company of America fellowship in the School of Chemical Engineering at the University of Oklahoma. Huitt, a graduate of Louisiana Polytechnic Institute, now is a graduate assistant and is working toward a master's degree. His research pertains to a study of "The Catalytic Dehydrogenation of n-Butane."

THE MONTH...

Jersey Standard Busy With New Research Units

Dedication this month of its new laboratory at Baton Rouge, La., is anticipated by Standard Oil Company of New Jersey.

Standard Oil Development Company, central research affiliate, expects to complete the first of a group of new buildings at Linden, N. J., this spring.

Research devoted to synthetic gasoline, diesel fuels and chemicals from natural gas and coal will be conducted. A large pilot plant at Baton Rouge is investigating application of fluid catalyst technique to the production of such from natural gas.

Johns-Manville Buys Van Cleef Bros. Company

Johns-Manville Corporation has purchased Van Cleef Bros., Inc., of Chicago, manufacturers of "Dutch Brand" industrial and automotive products.

The Chicago firm will be operated as a wholly owned subsidiary of Johns-Manville Corporation with no change being made in the manufacturing, merchandising or distribution system of Van Cleef. The present personnel is being continued in the Van Cleef organization.

Production in New Plant

The first production unit of the new Willow Island, W. Va., plant, of Calco Chemical Division, American Cyanamid Company, has been put into operation with a second large unit scheduled for operation this month. All construction work and installation of equipment scheduled for the current plant construction program is expected to be completed by early spring 1948.

The management of the Willow Island plant comprises D. H. W. Felch, plant manager; J. W. Dykes, production manager, and R. C. Lantz, personnel manager.

California Changes

California personnel changes were announced last month as follows:

Foster M. Stephens has been advanced from director of development of Fluor Corporation to assistant manager of manufacturing.

Arthur F. Bridge has been elected president and general manager of Southern Counties Gas Company. Formerly Bridge was vice president and general manager.

McCabe Now Vice President

Eugene F. McCabe, general sales manager of the Eastern division sales department of Tide Water Associated Oil Company, has been appointed a vice president of the company. He will continue in charge of the company's Eastern division sales department.

McCabe has had more than 25 years' service with the company.

Regional ACS Meeting

Seven hundred attend at Houston and hear wide range of technical discussions

More than 700 chemists and engineers attended the third southwest Regional meeting of the American Chemical Society held in Houston, December 12-13. Advances in the study of petroleum chemistry and several other fields were reported in the 50 papers presented.

Dean Samuel Colville Lind of the University of Minnesota, who was president of the society in 1940 and who is internationally known for his contributions to the world's knowledge of radium and radioactivity, delivered the feature address, "Research Within the Atom."

Chairmen of various sessions included J. L. Riebsomer of the University of New Mexico, D. R. Carmody of the Texas State Research Foundation, W. A. Felsing of the University of Texas, and O. M. Smith of Oklahoma A. & M.

Among papers with particular interest for refinery men was "Filtration of Refinery Slop Oils and Emulsions," by E. Q. Camp and C. Phillips of Humble Oil & Refining Company. The recovery of waste oils and emulsions lost to the sewer in various refining operations, and the discharge of an effluent water of acceptable quality, are associated problems in connection with the operation of a petroleum refinery which are assuming increasing importance. This paper described a pilot scale investigation of the continuous precoat filtration process as a means of resolving stable refinery emulsions and improving the quality of recovered slop oil. It is concluded from this work that the filtration process is effective in cleaning up recovered refinery slop oils and emulsions, and at the same time improving the quality of the effluent water.

A new fluid alumina catalyst made up of rounded particles of unusually uniform size was discussed by V. M. Stowe, E. E. Marshall, L. L. Nickel (deceased), and R. S. Greenwood of the Aluminum Research Laboratories of East St. Louis. The material is free-flowing, fluidizes readily, and is exceptionally resistant to abrasion. Tabletted samples of fluid alumina and commercial fluid silica were tested as catalyst for cracking kerosene. The alumina gave more liquid product to higher aromatic content, and less conversion of feed stock to heavy gases. This invites exploitation of the advantages of the fluid technic in the numerous fields where acivated alumina is required as a catalyst or sorbent.

Fuel Stability Tests

In "A Review of Fuel Oil Stability Tests," by A. R. Rescorla and D. V. Grew of Cities Service Refining Corporation at Lake Charles, La. the data of stability of a series of commercial fuel oils obtained on the open market was reported and analyzed. These oils were stored for varying periods of time to simulate consumer storage. At regular intervals samples were analyzed for stability as indicated by the copper couple resin test, high temperature evaporation, and acid flocculation test. The procedure was followed for the same oils when heat and light treated.

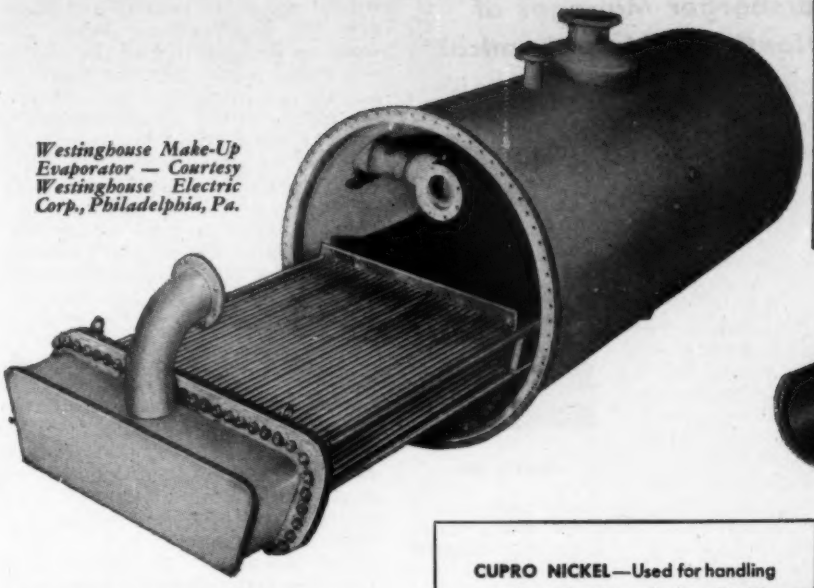
"A Study In The Naphthenic Acid Series" discussed the isolation of a relatively pure naphthenic acid from Aruba petroleum crudes. The isolation was accomplished through ether extraction of aqueous solution of the potassium salt and repeated fractional distillation of the acid and its methyl ester. Significant physical constants for the acid and its methyl ester have been determined and were presented. Henry E. Baumgarten and G. H. Richter of Rice Institute, Houston, subjected the acid to degradative studies. The properties and physical constants of several resultant products were determined and recorded together with possible structures.

F. D. Rossini of the Bureau of Standards presented discussion of the thermodynamics of the hydrocarbons occurring in petroleum and certain petroleum products. He covered the range of hydrocarbons found in certain natural gasolines and in a gasoline obtained as a product of catalytic cracking of gasoil at 450° C. and concluded that 1) within a given class of hydrocarbons thermodynamic equilibrium appears to be substantially established among the individual compounds, except among the isoparaffins in the case of isomers having quaternary carbons, and 2) that between different classes of hydrocarbons equilibrium appears to be nearly established between the cyclopentanes and cyclohexanes, but not appreciably between any other two classes, although undoubtedly some movement toward equilibrium does occur in the catalytic reaction.

Rossini's Conclusions

With respect to natural gasoline, Rossini concluded that 1) within each of the five classes of hydrocarbons the individual compounds are present in relative amounts which are of the same magnitude in different petroleums; 2) the gasoline fractions from different petroleums vary because of differences in these relative amounts of the five classes; 3) excluding among the isoparaffins those isomers having quaternary carbons, the average relative amounts of the individual compounds within a given class of hydrocarbons in the petroleum as it comes from the ground corresponds substantially to the relative amounts which would exist in thermodynamic equilibrium in the gas phase at temperatures in the neighborhood of 400° C. This latter point must be given serious consideration in the development of any theory describing the origin of petroleum.

Otto Beeck of Shell Development Company discussed the use of metal films as catalysts. Two important methods for studying surface catalysis are by adsorption phenomena and by utilization of magneto-chemical methods for information as to the valence state of material showing paramagnetism. Dr. Beeck considers surface catalysis the most important study in the general field of catalysis. The use of nickel and



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Solve a wide variety of corrosion problems

More efficient operation and less frequent shutdowns of your heat exchanging equipment result from using the *right* condenser tubing alloy.

Bridgeport has developed a variety of condenser and heat exchanger tube alloys to meet a wide range of conditions found in petroleum refineries, food, chemical and other processing plants. Our laboratory is prepared to work closely with you in making actual service tests to help you select the alloy or alloys best suited to meet your operating conditions.

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DUPLEX TUBING — for double corrosive conditions too severe for a single metal. Widely used in ammonia refrigeration and for heat exchangers and condensers handling a variety of corrosive liquids and gases. Available in copper-base condenser tube alloys combined with steel, aluminum, stainless or monel, either inside or outside.

CUPRO NICKEL—Used for handling caustic and other alkaline liquids, salt solutions, sea water and numerous gases.

DURONZE IV*—(aluminum bronze)—exceptionally resistant to hot brine in salt refineries; polluted sea and brackish water, and gives fine service against corrosive liquids in many processing industries.

CUZINAL—(aluminum brass)—especially suited for marine installations where impingement corrosion is a factor.

ARSENICAL ADMIRALTY—widely used for handling sea water or polluted fresh water, hydrocarbon gases containing sulfur compounds, gasoline, lubricating oils, etc.

ARSENICAL MUNTZ**—has high resistance to sulfur attack as well as to dezincification from certain types of corrosive fresh or saline waters. Effective for handling sulfur-bearing oils and gases.

*U. S. Pat. No. 2,093,380
**U. S. Pat. No. 2,118,688

Condenser and Heat Exchanger Tubing
BRIDGEPORT BRASS

other metals of the transition series was discussed in particular. The hydrogenation of ethylene with the metal film on a highly degassed glass surface was used as an example. The crystal plane was found to be highly oriented to the back of the catalyst and that the activity of the catalyst in this case was five times that obtained when the orientation was random. The high degree of orientation was brought about in an inert gas instead of a vacuum and leads to a possible correlation between crystal parameter and catalyst activity.

"Distribution of Carbon Dioxide Between Aqueous and Liquid Hydrocarbon Phases," presented by Robert McCay, Dwight Seely and F. T. Gardner, University of Tulsa, discussed the distribution coefficient versus pressure isotherms determined at 40° C. for two liquid phase systems saturated with carbon dioxide. A pressure-volume cell tested to 500 atmospheres was employed for the determination. The maximum pressure at which a gaseous phase may exist in a system containing one or more liquid phases, is determined from the P-V isotherms for a system containing known weights of hydrocarbon, 5 percent solution NaCl, and carbon dioxide. A series of such points was determined varying the quantity of carbon dioxide but employing fixed quantities of brine and hydrocarbon. A second series was determined differing from the first only in that the fixed quantity of hydrocarbon or brine is greater. Data from the two series were employed to determine distribution coefficients over the range of pressures studied. The upper pressure limit studied for each system is the maximum pressure at which a liquid phase containing carbon dioxide and hydrocarbon may exist at 40° C.

Paper by Oblad and Boedeker

The molecular weights, molecular weight distribution, and intrinsic viscosities of two polypropylenes of different viscosities and viscosity-temperature characteristics were discussed by Alex G. Oblad and Edward Boedeker of the Texas State Research Foundation. The polymers were fractionated by means of solvent fractionation and precipitation into a number of fractions sufficient in number to obtain the differential molecular weight distribution of polymers and the relationships between molecular weight, kinematic viscosity and intrinsic viscosity. Kinematic viscosity, intrinsic viscosity and number average molecular weight were determined for each fraction. The logarithm of the kinematic viscosity was found to be a quadratic function of the square root of the number average molecular weight. It was also found that fractions of similar molecular weight from the two polymers had nearly identical kinematic and intrinsic viscosities. This led to the conclusion that the difference in viscosity temperature characteristics between the two polymers was related to the molecular weight distribution since the differential molecular weights were found to be quite different for the two whole polymers.

W. R. Purcell of Shell Oil Company, Inc., Houston, and W. O. Milligan, J. L. McAtee, and Arthur L. Draper of Rice Institute presented a paper, "X-ray Diffraction Examination of Alumina Precipitated from Sulfate Solutions." According to this report, alumina was precipitated at various pH values from an aluminum sulfate solution by the addition of varying amounts of NaOH. The resulting gels were aged in the mother liquor at about 100° C. for periods of time up to several days. From intensity measurements on the X-radiograms taken at definite time intervals, estimates were made of the rate of formation or crystal growth of the basic aluminum sulfate. The basic sulfate forms very rapidly at low pH values, and forms very slowly at higher pH values. Above pH value of 5.5 the rate is extremely slow, confirming previous observation that no detectable amount is formed in 24 hours. Above a pH value of about 7.5 the alumina gel ages directly to -Al_2O_3. H_2O.

"Electron Diffraction Studies of Compounds Absorbed On Metal Surfaces," by Normann Hackerman and Harold R. Schmidt, University of Texas, resulted from an investigation of the mechanism of corrosion inhibition by polar organic substances. In order to learn more about the nature of the attachment and structure of the adsorbed materials it was decided to obtain electron diffraction patterns of the adsorbed compounds. The surfaces were treated by smearing, melting, or placing a drop of a solution on polished steel specimens. Three distinct types of patterns were obtained and calculations showed that the patterns were due in large part to the hydrocarbon structure.

In some instances the final pattern was not obtained at once. Instead the fluorescent screen was at first void and then after a short time a hazy pattern appeared which changed gradually to one indicative of a highly oriented structure. The time required for these changes was in general reproducible to about 1 minute.

The firmness of the adherence of the adsorbed material was determined qualitatively by obtaining a pattern as described, then washing the steel specimen with solvent, drying, and then exposing to the beam again. In the case of one inhibitor, for example, it was found that the pattern obtained originally was not affected by this treatment. On the other hand, for a second material the original pattern disappeared and one due to iron was found.

Propane Dewaxing

Propane dewaxing was discussed by N. F. Chamberlain, J. A. Dinwiddie and J. L. Franklin of Humble Oil & Refining Company, in "Studies of Wax Crystalization from Propane Solution." A fundamental approach to the problem of propane dewaxing was made through microscopic studies of wax crystals from a mid-continent distillate. Wax crystals were observed in their normal environment at various stages of the

Hersberger Manager of Atlantic Refining Chemical

Appointment of Dr. Arthur B. Hersberger as manager of the recently organized chemical products division of The Atlantic Refining Company was announced last month. This division will have the responsibility of co-ordinating company activity in the fields of chemical research, chemical manufacturing and chemical sales.

Hersberger

Dr. Hersberger has served with Atlantic's research and development department since 1936. He is a graduate of the University of Maryland. Since April, 1944, he has been a divisional director of the research and development department.

Late Developments in Lubricants

Development of lubricants for service at low temperatures is guided by many precision tests and laboratory measurements, but the actual performance possibilities of a given oil are often more clearly demonstrated by application tests such as the one shown above. Here a watch, frozen stiff in a block of ice, still runs smoothly and keeps perfect time. The reason is a specially developed lubricant which does not congeal at extreme low temperatures. This test is used at the research laboratories of Cities Service Company at Hillside, N. J. In the other illustration, Russell E. Lowe of that laboratory holds two test tubes containing oils which are under comparison after being subjected to an acetone, dry-ice bath at temperatures of —70° F. In the tube at the left, oil especially developed to withstand extreme low temperatures remains fluid. In the other tube the oil is congealed.

(One of a series of advertisements describing the steels used by Bethlehem in the manufacture of high-temperature fastenings)

They've got what it takes

The three grades of heat-treated alloy steel bolting given above were recently added to ASTM Specification A193, as replacements for Classes A, B, and C of Specification A96, now discontinued. They are designed for use in high-temperature, high-pressure refinery service, and conform to the following requirements of the specification:

CHEMICAL REQUIREMENTS

		Range	Check Variation Over
BA, BB, BC	Phosphorus, max, pct	0.04	0.005
	Sulphur, max, pct	0.04	0.005

TENSILE REQUIREMENTS

Grade	Diameter in.	Minimum Tempering Temperature F	Tensile Strength min. psi	Yield Point min. psi	Elongation in 2 in., min pct	Reduction of area, min pct
BA	2½ and under	1200	95,000	70,000	20	50
	Over 2½ to 4, incl.	1200	90,000	65,000	20	50
BB	2½ and under	1100	105,000	80,000	20	50
	Over 2½ to 4, incl.	1100	100,000	75,000	20	50
BC	2½ and under	1000	125,000	105,000	16	50
	Over 2½ to 4, incl.	1000	115,000	95,000	16	45

Grades BA, BB, and BC are three of eight steels which are currently being produced by Bethlehem for the manufacture of studs, bolts and set-screws. Others in the group are: B7, B7a, B13, B14 and A261, a range so complete that it meets virtually every bolting condition involving high temperatures or high pressures.

In addition to its completely-equipped fastenings plant at Lebanon, Pa., Bethlehem has an engineering staff that is thoroughly familiar with refinery bolting conditions. So get in touch with us whenever you have a difficult bolting problem. Address the nearest Bethlehem district office, or drop a line to us at Bethlehem, Pa.

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chilling period by means of a pressure cold stage. When no dewaxing aid was present the wax crystallized in plates which were arranged in either a flat or honeycomb structure. When a small amount of asphalt was added as dewaxing aid, the wax crystallized rapidly immediately below the crystal point into spherical particles of unknown structure, arbitrarily defined as nuclei. As chilling was continued, these nuclei were quickly surrounded by a shell of radiating needles. When large amounts of asphalt were used, a great number of small nuclei were formed at the crystal point and grew slowly until the filtering temperature was reached; these formations never developed the surrounding shell of radiating needles. Filtering characteristics were critically dependent upon the type of wax structure present.

The oxygen demands of certain compounds was discussed in a paper presented by T. W. Kirby, Jesse A. Woods and A. R. Rescorla of Cities Service Refining Corporation, Lake Charles, La. In this study the substances investigated were sulfides, sulfites, thiosulfates, and elementary sulfur; cyanides and their hydrolysis products such as cyanates, formic and oxalic acids, urea, and ammonia; some soaps; and the phenolic compounds which were likely to occur.

Infrared Analysis

Several papers were presented on infrared analysis. J. Rud Nielsen, Lucile Bruner and Kjersti Swanson, University of Oklahoma, outlined the infrared absorption of phenyl- and cyclohexyl-eicosanes, and made a detailed comparison between the spectra of individual members of either series of compounds. "The Application of Infrared Spectroscopy to the Determination of Olefins in Gasoline", by R. W. B. Johnston, W. G. Appleby, and M. O. Baker of Shell Oil Company, discussed the development of infrared adsorption for the determination of alpha olefins and the total beta, gamma, and delta olefins in gasolines. James A. Anderson, Jr., and C. E. Zerwekh, Jr. of Humble Oil & Refining Company, Baytown, Texas, described new techniques in the determination of impurities in reference-fuel grade isooctane and normal heptane. E. C. Daigle and J. H. Lee of Magnolia Petroleum Company presented a rapid machine method for calculating results of infrared analyses of gaseous hydrocarbon mixtures. This procedure also has other applications where simultaneous equations are involved, as in mass spectrometry. It is customary to analyze light hydrocarbon mixtures using the mass spectrometer, the infrared spectrometer, or fractional distillation with subsequent chemical assay of the cuts. In some of these cases, several of these methods are used to determine the composition of the same sample. The most probable analysis is then calculated from the results of these separate determinations.

Daniel Milson, W. R. Jacoby, and A. R. Rescorla of Cities Service Refining Corporation at Lake Charles, presented a method of complementary analysis of light hydrocarbons which utilized the equations from infrared and mass spectrometer data which will yield the most probable analysis in a single computation.

J. H. Karchmer and J. W. Dunahoe of Humble Oil & Refining Company described a rapid volumetric method for the determination of sulfides, thio-sulfates, and sulfites in refinery spent caustic solutions.

A simplified rapid procedure for the determination of carbon and hydrogen by combustion was outlined by V. L. Lescher of Esso Laboratories, Louisiana Division.

The near ultraviolet adsorption spectrum of styrene vapor, as reported by J. F. Music, W. W. Robertson, and F. A. Matsen of University of Texas, has been studied for the region (2400° A.—3000° A.) with a grating instrument of inverse linear dispersion of approximately 2.75° A. per mm.

Determination of Olefins

An analytical procedure for the determination of olefins by reacting the olefins with an excess of iodine monochloride in a carbon tetrachloride solution in the presence of mercuric acetate catalyst was described by R. B. Perkins, Jr. and John A. Grant of Pan American Refining Corporation. The catalyzed iodine monochloride addition procedure has been found to be a useful tool for the determination of olefinic hydrocarbons. Its use on mixtures of unknown composition was discussed.

An anticipated increase in the quantity of "spent" doctor solution necessitated study of methods of increasing the capacity of the regeneration facilities at the Baytown refinery of Humble Oil & Refining Company, according to discussion by R. M. Love and J. C. Shaw, of that company, who outlined a procedure of regeneration adopted. The method included separation of a slurry of spent lead particles from the spent solution, oxidation of these particles by air blowing in an open tank, and dissolving the oxidized particles in caustic to yield the regenerated doctor solution. Theoretical considerations of the mechanism of the oxidation and solution reactions indicated that the rate of both is controlled by diffusion rates rather than by chemical reaction rates or approach to equilibrium. Laboratory and plant data on a number of the variables affecting diffusion rates were presented and discussed.

Relationships earlier suggested by V. A. Kalichevsky for estimating yields and properties of products from the solvent refining of lubricating oils were expanded to include the temperature gradient used to increase the efficiency of counter-flow extraction towers in a discussion by E. J. Reeves of Magnolia Petroleum Company. Analysis of the new functions proved the existence of optimum raffinate and extract reject temperature which gave the greatest yield and highest quality product. The numerical values of these optima are found by substitution of experimentally determined constants in simple algebraic expressions. Several examples showing the practical applications of these relations, were presented.

Ernest W. Bowerman of Humble Oil & Refining Company outlined a test procedure that permitted a quantitative measurement of the activity of catalyst used to saturate olefins. The method involved the determination of the rate of olefin hydrogenation, expressing the catalyst activity in terms of the reaction rate.

In discussing low temperature fractional distillation, C. E. Starr, Jr., J. S. Anderson and Van M. Davidson of Esso Laboratories, Louisiana Division, presented results obtained in which optimum distillation rates and fraction cut-points were determined. Distillations were made at different rates and the heart cut of each fraction was analyzed by mass spectrometer for contamination by lower and higher boiling constituents. Also, analyses were made of fractions taken between major boiling points to determine if generally accepted cut points were optimum. It was found that high distillation rates may be used with negligible contamination, if the column is operated properly, and that the amount of hydrocarbons distilling between boiling points is quite small. The contamination of one fraction with another, using generally accepted cut points, is negligible, and is usually due to the lower boiling fraction.

ACS Heads Take Office

American Chemical Society has announced the election of Dr. Linus C. Pauling as president for 1949. Dr. Pauling, chairman of the division of chemistry and chemical engineering of California Institute of Technology, took office as president-elect on January 1. At the same time, Dr. Charles A. Thomas, executive vice president of Monsanto Chemical Company, became society president for 1948.

CCDA Meeting

The Commercial Chemical Development Association will hold its annual meeting in New York at the Roosevelt Hotel, March 9 and 10, 1948.

Financial aspects of chemical development will be discussed at the morning meeting on March 10 and at the luncheon. The afternoon session will be devoted to gearing commercial chemical development to sales, research, and manufacturing.

Lauren B. Hitchcock, vice president of Quaker Oats Company, Chicago, is president of CCDA.

Rogers Lacy Dies

Rogers E. Lacy, 63, East Texas oil man, died December 9 at Longview. He had been ill since September 29. Born at Longview on August 18, 1884, Lacy turned first to railroading, then to farming and mercantile ventures. Oil development in 1931 proved his land to be in the heart of the mammoth East Texas field. In addition to his East Texas holdings, Lacy was an important factor in the development of oil in southern Mississippi, where in 1946 he built the state's second refinery. He owned a block in the heart of Dallas' business district, where he had planned a $10 million, 47-story hotel.

Paul Devereux Dies

Paul A. Devereux, 51, district manager for Sun Oil Company at Detroit, Mich., and former Philadelphia Northeast High School and Muhlenberg College athlete, died suddenly December 21 at Grosse Pointe, Mich.

Devereux joined Sun in 1931 and has served in various capacities. He became district manager at Worcester, Mass. in 1939, was appointed district manager at Hartford, Conn. in 1940 and four years later became district manager at Detroit.

SCIENCE *and* TECHNOLOGY ABSTRACTS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

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Fundamental Physical and Chemical Data

Heats of Formation and Isomerization of the Eight C_8H_{12} Alkylcyclohexanes in the Liquid and Gaseous States. E. J. Prosen, W. H. Johnson and F. D. Rossini, *J. Research Natl. Bur. Standards* **39** (1947) pp. 173-5.

Heats of Isomerization of alkylcyclohexanes into the given dimethylcyclohexane in the gas state at 25° C., and at 0° K., as well as the heats of formation were calculated. Values of the energy content for the gaseous state at 0° K. are preferred because all the molecules of a given isomer will then be in the tautomeric state of lower energy, as well as for translational, rotational, and ordinary vibrational energy. The difference in energy due to a change of a methyl group from the equatorial to the polar position is evaluated from experimental data 1.94—0.10 kcal/mol.

Factors that Influence Thermal Conductivity of Porous-Type Insulating Materials. A. V. Butterworth, *Chem. Eng. Progress* **43** (1947) pp. 597-600.

Data were obtained on the effect of pressure, temperature composition of the gas atmosphere, and service age on the thermal conductivity of rock-wool insulation. The work shows that the conductivity of rock wool increases linearly with temperature at a rate that is independent of the pressure, and that it increases at a decreasing rate with increasing pressure, indicating that increased convection in the pore space may be responsible, thirdly, changes directly with the k of the gas filling the insulation pores, and fourthly, the conductivity does not increase markedly when operated at a 600° F. *average* temperature in a hydrocarbon-hydrogen atmosphere for a period of 1100 hours.

Mean Molecular Weights of Asphalts and Their Constituents. George W. Eckert and Bruce Weetman, *Ind. Eng. Chem.* **39** (1947) pp. 1512-16.

During studies of the characteristic components of asphalts, namely, asphaltenes, resins, paraffin oils, naphthene oils, and waxes, it became a matter of interest to determine the mean molecular weights of these fractions. No general agreement exists in the literature with respect to the molecular weights of the asphaltenes. The method of measurement based on the viscosity of dilute solutions was investigated for its applicability to asphalts and their components. The equations proposed by Staudinger for calculating molecular weights from viscosities of solutions was considered. The constants in the equations were evaluated by using cryoscopic molecular weights for the oil and resin fractions. Molecular weights of the oils and resins ranged from 370 to 900. Viscosities of benzene solutions were determined at 77° F. in a capillary type viscometer. Mean molecular weights of 700 to 1800 were obtained for the asphaltenes for asphalts from different sources. Both equations proposed by Staudinger were used to calculate molecular weights of asphaltenes, and neither of them appears preferable to the other. Reliable independent data for the molecular weights of asphaltenes are not available in order to define conclusively the constants in the original and modified forms of Staudinger's equations. Molecular weights of asphaltenes increase with the increase in time of air blowing of the original asphalts.

Chemical Compositions and Reactions

Copolymers of Butadiene with Halogenated Styrenes. C. S. Marvel, G. Esler Inskeep and Rudolph Deanin, *Univ. of Ill.*, and A. E. Juve, C. H. Schroeder and M. M. Goff. *B. F. Goodrich Co., Ind. Eng. Chem.* **39** (1947) pp. 1486-90.

Work was undertaken to obtain information on the copolymerization of halogenated styrenes with butadiene, as well as to learn advantages and disadvantages of the various copolymers as substitutes for rubber. Chlorostyrenes are potentially available in quantity and should be reasonably cheap. Some twenty halogenated styrenes were copolymerized with butadiene in a typical emulsion polymerization formula. Based on laboratory evaluations of small samples, the quality of most of the copolymers was approximately equal to that of GR-S. There are indications that the copolymers containing 2,5-dichlorostyrene, 3, 4-dichlorostyrene, and *p*-cyanostyrene are superior to GR-S in several respects.

Isomerization of 10 and 2-Pentenes. A. G. Oblad, Joseph U. Messenger and H. Trueheart Brown, *Ind. Eng. Chem.* **39** (1947) pp. 1462-6.

Recent workers in the field of catalytic vapor-phase olefin isomerization are in substantial agreement with regard to the type of catalyst required for double bond shifting and for skeletal isomerization. There is, however, wide variation in the activities of the catalysts employed. The authors studied the vapor-phase isomerization of 1-pentene and 2-pentene over the temperature range 177 to 427° C. and at liquid space velocities from 0.5 to 24 hours. The catalysts used were aluminas of low sodium content and of acidic nature. Reactions all the way from simple double bond shifting to skeletal isomerization occurred, depending on the chemical nature of the catalyst surface and the temperature of the reaction. Based on the apparent similarity between the nature of the solid catalysts studied and the acidic catalysts commonly used in liquid phase reactions, a mechanism involving carbonium ions is proposed to explain the vapor phase isomerization of olefins. The shifting of the double bond in *n*-pentene appears to be a rapid reaction catalyzed by neutral alumina even at low temperatures. Skeletal isomerization requires higher temperatures and catalysts of a more acid character. Branched-chain olefins can be prepared from either 1- or 2-pentene. Equilibrium is rapidly established between these straight-chain olefins.

Manufacture: Processes and Plant

Pressure Drop Through Packed Tubes. Part II. Effect of Surface Roughness. Max Leva and Milton Grummer, *Chem. Eng. Progress* **43** (1947) pp. 633-8.

In a previous paper an equation for pressure-drop was given for the flow of gases through columns packed with smooth particles. It did not taken into account the effect of surface roughness of the packing on pressure drop. The present investigation was concerned with the pressure drop through particles of different degrees of surface roughness. It was found that particles that are as rough as clay or alundum increase the pressure drop by about 50 percent. For particles such as irregularly shaped dense Aloxite granules, which are much rougher than clay particles, the pressure drop was more than twice as high as was observed with smooth particles. These observations are shown in a graph where modified friction factors are plotted on logarithmic coordinates versus the modified Reynolds numbers.

"Fiberglas" Packing in Gas Absorbing Systems. G. C. Williams, R. B. Akell and C. P. Talbott, *Chem. Eng. Progress* **43** (1947) pp. 585-96.

The paper comprises a report on the mass velocity and the mass-transfer

characteristics of Fiberglas packing when used in a vertical jackstraw arrangement in a 1-ft. diameter column. Data are given for air-water system pressure drops from dry-packing to water flows of 75 gal./min./sq.ft. of tower cross section and with air rates up to 5.8 ft./sec. Loading occurs at pressures of about 0.3 in. of water/foot of packing, and flooding at about 0.4 in. of water. However, visual flooding is not found to occur until pressures of 0.5 to 0.7 in. of water are attained, and even at this figure there is no liquid build-up on the packing. Values of the gas-phase coefficient, height of a transfer unit, and height equivalent to a theoretical plate are presented for the system, air-water-ammonia, up to flooding conditions. The values of the coefficient are 1.5 to two times those of fine quartz or coke. The use of "Fibergias" as a packing material for towers is recommended for systems where high gas and liquid rates are employed, and where medium values of the H.T.U. are permissible.

The Fluid Solids Technique: Applications in the Petroleum Industry. E. V. MURPHREE, E. J. GOHR AND A. F. KAULAKIS, *Jour. Inst. of Petroleum* **33** (1947) pp. 608-620.

The use of fluid catalyst potentially has application to any process in which large quantities of heat are transferred, or in which very intimate contact between gases and solids is desired. The paper explains the basic principles of the fluid-solid technique and describes three applications of development in the petroleum field, namely, the catalytic processing of gas oils, the extraction of liquid fuels from shales, and the synthesis of the higher hydrocarbon homologues from natural gas. The technique depends on the application of two basic properties or characteristics of finely-divided solids. These are

1) Properly sized solids, when mixed with a gas, will form a homogeneous solids-gas mixture or "fluid", having flow properties similar to ordinary liquids but having a density subject to variation through simple manipulation or either the solids to gas ratio or the flowing conditions, and

2) powdered solids, when suspended in a gas stream flowing upwards at relatively low velocities, will form, contrary to Stokes' law, a continuous dense phase which in many aspects resembles a boiling liquid and which assumes a relatively well defined level.

The first of these makes possible the circulation of large quantities of solids without benefit of mechanical devices, such as pumps. The second property provides the means for carrying out such functions as heat transfer under excellent conditions, and also allows reaction time requirements in reasonably sized equipment. The fluid solids technique as applied to manufacturing processes consists essentially of either one or both of two basic elements, first, a circulating system and a zone in which a concentrated or "dense phase" of solid is built or maintained for the basic purpose of carrying out a desired reaction. After describing three typical operations the author suggests applications in other industrial fields.

Automatic Control of Refinery Operations. W. S. AULT, B.A. (Fellow), *Jour. Inst. of Petroleum* **33** (1947) pp. 598-607.

The author reviews the knowledge of the theory of automatic control that operating personnel should have in order to get the most out of instrumentation. Typical examples of instrumentation in refinery work are considered, treating the subject from the viewpoint of the plant operator rather than from that of the instrument engineer. Design of instruments is not considered, but stress is laid on the capabilities of the instruments and the means by which they can be made to give the best results. The subjects of load, throttling range, departure from the control point, and automatic reset are among those briefly discussed. On-and-off controllers, throttling controllers, and throttling controllers with automatic reset are briefly described.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

3-Ethyl-1,2-benzoquinone
4-Ethyl-1,2-benzoquinone
3-Methyl-1,2-benzoquinone
4-Ethyl-1,2-naphthoquinone
Benzyl hyponitrite
p,p'-Dibutyldiphenyl sulfide
α-Truxillic acid
β-Truxinic acid
Methyl chloramine
Aluminum lauryl phosphate
1,2-Dichloroisobutane
Benzoxanthene
Anthrafurane
2,6-Dimethylnonane
Acetthiooxime
1,3-Dimercaptopropane
1,5-Cyclooctadiene
Cyclobutadibenzene
Hydroquinone sulfonic acid
Cyclooctatetraene
3-Furfuryl alcohol
2-Propenylpyridine

How "N" System Simplifies Piping Cost Estimation. R. A. DICKSON, *Chem. Eng.* **54** (1947) No. 11, pp. 121-3.

Piping represents a substantial proportion of equipment cost in most process plants. Furthermore, the estimation of its cost is usually laborious. The N System described in the article is based on the simple fact that the cost of a string of pipe of any size bears a predictable relation to the cost of the same string in another size. Hence only the cost of the "reference" string of each kind of pipe need be kept up to date. For insulated lines the "reference" string is calculated with insulation added and the N factor used as for bare pipe. This does not apply to cork insulation, which is handled by another procedure. Charts of N factors are given for standard weight steel pipe, extra heavy steel pipe, double extra heavy pipe, standard weight 4-6 percent chrome steel pipe, iron pipe size brass pipe, and cast iron bell-and-spigot Class C pipe. Examples of the application of the procedure are included.

Continuous Viscosity Measurement. WILLIAM A. DIAMENT, *Chem. Eng.* **54** (1947) No. 11, pp. 136-7.

In the course of ten years of hydraulic research into the behavior of normal but different fluids in area type flow meters, intensive study was given to the viscosities of the fluids as well as their other characteristics. Out of these studies came a new conception of viscosity measurement. This led to the development of new metering element float shapes that were immune to effects of varying fluid viscosities. It was also found that the conventional plumb-bob float was sensitive to viscosity effects. Combining these two floats in a series in a single fluid stream made possible the continuous measurement of viscosity. Comparative viscosity effects of the so-called "Stabl-vis" type of float and the conventional plumb-bob type are shown graphically. The author describes a new viscosity unit and gives an equation for its conversion to centipoises. Measurement of high viscosities is discussed and described.

Substitutes for Soda Ash in the Treatment of Boiler Feed Water. W. A. TANZOLA, R. L. REED AND J. J. MAGUIRE, *Ind. Eng. Chem.* **39** (1947) pp. 1440-3.

The current shortage of soda ash is a matter of concern in connection with the treatment of boiler feed water when the lime-soda softening process is used to treat make-up water. Caustic soda can be used in place of lime and soda ash when the carbonate and non-carbonate hardness of the water are in proper proportions. In some instances internal chemical treatment of the boiler water permits lime softening without the use of soda ash, and in some other cases recirculation of boiler water to hot-process lime-soda softeners is effective. Substitution of zeolite in a filter bed can serve temporarily by blending the zeolite effluent with lime-softened water. Barium carbonate has been used as a satisfactory substitute for soda ash although the cost is higher and restricts its use to emergencies.

Refining South American Crudes. DAVIS READ AND GUSTAV EGLOFF, *Jour. Inst. of Petroleum* **33** (1947) pp. 621-47.

The volume of crude oil from producing countries in South America is expected to increase during the next few years. The paper presents a summary of information now available on the properties of several South American crudes and illustrates the application of several processes in the refining of these oils. Properties of the crudes are given in tabular form. Results of cracking of charging stocks from these crudes are presented in some detail. Chemical treatment procedures required are briefly considered.

Flow of Fluids Through Porous Media. Part II. Simultaneous Flow of Two Homogeneous Phases. LLOYD E. BROWNELL AND DONALD L. KATZ, *Chem. Eng. Progress* **43** (1947) pp. 601-13.

The paper is a continuation of a previous paper dealing with the single-phase flow of fluids through porous media and is an extension to cover the simultaneous flow of two fluid phases. Each fluid is treated as a single phase, with modifications for the effect of one fluid on the other. An additional correlation is developed to predict the quantity of fluid held in a porous bed by capillary forces. By use of the general flow equation both countercurrent and parallel flow of the two phases can be calculated. The wetting fluid flows through the same porous medium as would a single phase, but a velocity cor-

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Causplit Cement (most acids and alkalies)
Pennsalt HF Cement (acids, especially HF, H_3PO_4)
Pennsalt HFK Cement (quicker-setting HF cement)
Pennsalt PRF Cement (most acids, alkalies and solvents)
Pennsalt PRFK Cement (quicker-setting PRF cement)

rection must be applied to account for the proportion of wetting fluid that is replaced by the other fluid. The nonwetting fluid is considered as flowing through a porous bed which has a sphericity change and a porosity reduction due to the layer of the other fluid. A typical problem is given to demonstrate the use of the relationship developed for calculating "steady" state two-phase flow through porous media.

Products: Properties, Utilization and Analysis

The Effect of Sulphur and Phosphorus on Aviation Fuel Performance. T. K. HANSON AND K. F. COLES, *Jour. Inst. of Petroleum* **33** (1947) pp. 589-97.

The effect of small quantities of sulphur and phosphorous and their compounds on the performance of fuels is discussed both for octane ratings by motor method and by the rich-mixture performance ratings. The adverse effect of sulphur on engine performance of leaded fuels is much greater by the rich-mixture rating than by the motor method rating. Phosphorus, however, shows the reverse effect, having, for very low concentrations, a slight positive effect on rich-mixture rating. The effect on fuel performance of different classes of compounds containing these elements is discussed. Both sulphur and phosphorus compounds react in the combustion chamber with lead at ratios approaching the theoretical. Phosphorus itself can act as an anti-knock agent within a narrow range of concentration, and under rich-mixture test conditions.

Selenium Dioxide as a Lubricant Additive. RAY E. HEIKS AND FRANK C. CROXTON, *Ind. Eng. Chem.* **39** (1947) pp. 1466-74.

The oxidizing action of selenium dioxide is well known, but it is not so evident that selenium dioxide can also function as a powerful antioxidant. With several typical alcohols to increase its solubility selenium dioxide was found to act as an antioxidant for lubricating oils. The paper describes the results of bench and engine tests that indicate that the effectiveness of selenium dioxide is comparable to that of certain commercial antioxidants. An hypothesis explaining the antioxidant action of selenium dioxide is proposed. The data secured in the course of the work are presented in considerable detail in tabular and graphical form, and a bibliography of 16 references is included.

Automatic Vacuum Take-Off Arrangement for Fractional Distillation. T. F. BROWN AND K. F. COLES, *Ind. Eng. Chem. Anal. Ed.* **19** (1947) pp. 935-6.

In the close fractionation of higher-boiling narrow petroleum cuts, some form of automatic still control is essential. The device described is simple in operation and accurate. The apparatus can be used either under vacuum or at pressures above atmospheric. A bibliography of two references is included.

Procedure for Determination of the Bromine Number of Olefinic Hydrocarbons. HERBERT L. JOHNSON AND RICHARD A. CLARK, *Ind. Eng. Chem., Anal. Ed.* **19** (1947) pp. 869-72.

An improved method for the determination of bromine absorption by olefinic compounds in gasoline and similar products was developed. All hydrocarbons tested have been found to give results close to the theoretical except a few highly branched or sterically hindered olefins and anthracene. The method and procedure are described in some detail and the bromine numbers of a long list of hydrocarbons are presented. The authors feel that the procedure is adequate for use on the olefins present in gasoline, kerosine, and gas oil. A bibliography of 15 references is included.

Analysis by the Mass Spectrometer of a Liquefied Hydrocarbon Mixture Containg C_3-C_5 Paraffins and Olefins. V. H. DIBELER AND FRED L. MOHLER, *J. Research Natl. Bur. Standards* **39** (1947) pp. 149-54.

A study was made of two methods for removing small samples from a liquefied hydrocarbon mixture of known composition. A mass spectrometer was used as the instrument. The method of opening the cylinder valve and allowing the mixture to evaporate slowly into an evacuated reservoir shows varying compositions depending on the rate of evaporation. Removal of the sample as liquid followed by complete expansion into the gas reservoir gives consistent results. When a cylinder is nearly empty the liquid is no longer representative of the mixture within the range of precision of the analytical procedure. The work emphasizes the importance of improved sampling methods.

Determination of Small Amounts of Water in Gases and Liquids by Infrared Spectrometry. A. F. BENNING, A. A. EBERT AND C. F. IRWIN, *Ind. Eng. Chem., Anal. Ed.*, **19** (1947) pp. 867-8.

Accurate knowledge of the water content of the gas or liquid is frequently desired. A practical method for determining small quantities of water in liquid commercial refrigerants based on absorption of the water by phosphorus pentoxide and measurements of the increase in weight of the P_2O_5. This method, in the hands of a good technician, is accurate to only about 2 ppm at low water concentrations and requires about 4 hours' time for a determination. The authors present a method for the rapid determination of minute quantities of water in various solvents. This method is based on the measurement of the infrared absorption of a sample contained in a pressure absorption cell. Concentrations of water as low as 1 ppm can be determined.

Polarographic Determination of Naphthalenes in Petroleum Fractions. R. A. BURDETT AND B. E. GORDON, *Ind. Eng. Chem., Anal. Ed.* **19** (1947) pp. 843-6.

An analytical method for the determination of naphthalenes in petroleum fractions boiling in the kerosine or light gas oil range is described. The method is based on the reduction of the condensed ring bicyclic hydrocarbons at high negative potentials. Monocyclic aromatics, paraffins, naphthenes, and mono-olefins do not interfere. Higher polynuclear aromatics do interfere, but can usually be removed by distillation. Total time required for an analysis is 20 to 30 minutes. The apparatus, reagents and procedures are described and data are given for the analysis of known and unknown samples. A bibliography of eight references is included.

Optimum Conditions for Titrimetric Determinations. WILLIAM B. HUCKABAY, CLYDE J. NEWTON and A. V. METLER, *Ind. Eng. Chem., Anal. Ed.* **19** (1947) pp. 838-41.

A method for the determination of the traces of acetone in liquefied hydrocarbon gases is described and results are shown for samples of known acetone content. When an incomplete chemical reaction is to be used for a quantitative analysis certain variables will influence the dependability of the results. Optimum conditions for the reaction can be selected by a graphical method. A typical case is presented in which pH is the variable studied. A bibliography of 21 references is included.

Method for Particle Size Distribution for the Entire Subsieve Range. A. E. JACOBSON AND W. F. SULLIVAN, *Ind. Eng. Chem., Anal. Ed.* **19** (1947) pp. 855-60.

It is frequently desirable to determine the particle size distribution of finely divided material for the entire subsieve size range. The microscopic method appears to be the only direct means for such determinations, but is laborious and of doubtful value in many cases. Sedimentation procedures are based on fundamental principles and have proved suitable for the determination of particle size distribution for the subsieve size range. The theory underlying the use of a sedimentation pan, specific gravity cylinder, and a cylindrical cup is discussed. The mathematical equivalence of the sedimentation and the specific gravity methods is shown. A modified sedimentation balance that uses a tall cylindrical cup rather than a pan was employed for the determination of particle size distribution in ranges down to 1.0 micron. The use of the buoyancy factor increases the convenience of the method and decreases the time required for a complete determination. Examples given show the use of the cylindrical cup and centrifugal sedimentation methods for obtaining composite particle size distribution curves for the entire subsieve range. A bibliography of seven references is included.

Advance Orders Are Sought For Calorimeter Treatise

Southern California Meter Association is seeking advance orders for a paper "The Cutler-Hammer Recording Calorimeter" by Blake O. Cossey of Southern California Gas Company. Outlined are installation requirements, maintenace, various methods of calibration, as well as adaptations of this instrument and auxiliary equipment. It would contain many illustrations.

The association needs 100 advance orders at $1.25 per copy to members and $1.50 to non-members before publication. Orders may be placed with the Association, 2916 Eucalyptus Avenue, Long Beach 6, Calif.

Directory Available

Association of Consulting Chemists and Chemical Engineers, Inc., announce the availability of the eleventh edition of their Classified Directory for 1947.

This edition is amended and enlarged and contains a cross index listing specialized fields of members. Also included is an alphabetical list of the membership and a geographical location index.

This directory may be had without cost by giving source of reference, name of person and his company, complete address including postal zone number. Address Association of Consulting Chemist and Chemical Engineers, Inc., 50 East 41st Street, New York 17, N. Y.

DIGEST of Recent United States PATENTS Pertaining to PETROLEUM REFINING

AND COVERING PATENTS PUBLISHED IN THE OFFICIAL GAZETTE DATED OCTOBER 14, 21, 28 AND NOVEMBER 4, 1947

Compiled by HEINZ HEINEMANN

REFINING

USP., 2,428,815 Azeotropic Separation of Amylenes. C. R. Sandberg and G. B. Wren-Patterson to Socony-Vacuum Oil Company, Inc.

A/C_5 hydrocarbon stream containing n-pentane, isopentane, pentene-1, and pentene-2 is mixed with an amount of methylal sufficient to convert the compounds to their methylal azeotropes. The resulting mixture is fractionated to produce separate streams of all the azeotropes. The separate streams are treated with a solvent selective for the removal of methylal from the azeotropes, such as water. Separate streams of n-pentane, isopentane, pentene-1, and pentene-2, substantially free from methylal, are recovered.

U.S.P. 2,429,126. Method of Separating Butadiene and Acetylenes from Solution. R. A. Given to Standard Oil Development Company.

Butadiene and acetylenes are separated from an ammonial cuprous salt solution containing them in dissolved state by passing the solution into a packed tower and flowing it countercurrent to a butadiene-containing gas. Butadiene is withdrawn from the top of this tower. The residual cuprous salt solution is removed from the bottom of the tower and heated to a temperature of 150-170° F. The heated solution is introduced into the upper portion of a second tower and flown in countercurrent contact with acetylene-containing gas obtained by withdrawing cuprous salt solution from the bottom of the second tower and heating it to 170-190° F. Gas is withdrawn from the top of the second tower and introduced as the butadiene-containing gas into the first tower. From the mid-section of the second tower a side stream of gas rich in acetylenes and containing butadiene and ammonia is withdrawn. The ammonia is washed from this gas with water to obtain a product rich in acetylenes. The recovered butadiene can be employed in the manufacture of synthetic rubber.

U.S.P. 2,429,134. Extraction of Diolefins. C. E. Morrell and M. W. Swaney to Jasco, Inc.

A hydrocarbon mixture containing a diolefin, such as butadiene, and relatively more saturated hydrocarbons is contacted with a strongly basic ammonical cuprous salt solution having a pH value above 9.0, containing at least 2 mols per liter of cuprous copper, a cupric content of at least a trace, ammonia and an anion that forms a cuprous salt soluble in the ammoniacal solution. The resulting salt solution containing absorbed diolefin is separated from undissolved more saturated hydrocarbons, and the diolefin is recovered from this salt solution. The anion of the salt can be that of an organic carboxylic acid, such as acetic acid, lactic acid, or formic acid.

U.S.P. 2,429,965. Breaking of Emulsions. A. P. Shearer, L. B. Witten, and T. Cubin.

Sulphuric acid-hydrocarbon emulsions formed in the H_2SO_4-treatment of hydrocarbons, e.g. in the alkylation of isobutane or isopentane, are rendered more tractable by the addition to and distribution in the fresh concentrated H_2SO_4 of a polymer composition recovered from the H_2SO_4 spent in the treatment. A small amount of polymers, preferably not exceeding 5 percent of the acid, is employed. The emulsions are broken by this addition and the settling time for the components of the emulsion is appreciably reduced.

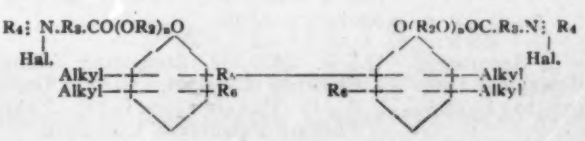
U.S.P. 2,429,996-2,430,003 Process for Breaking Petroleum Emulsions. M. DeGrote and B. Keiser to Petrolite Corporation, Ltd.

According to U.S.P. 2,429,996 a compound for breaking petroleum emulsions of the water-in-oil type consists of a hydrophile compound of the formula

$$R_1O(R_2O)_n\,OC.R_3.N{:}R_4 \cdot Hal.$$

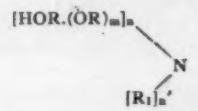
in which R_1 is a monocyclic phenol radical with 2-3 alkyl side chains at least 2 of which contain at least 4 C atoms; R_2O is a radical of ethylene oxide, propylene oxide, butylene oxide, glycide, or methylglycide; n is a whole number from 1-6; OC.R_3 is the acyl radical of a low molal monocarboxy acid with not more than 6 C atoms in which an alpha-hydrogen atom has been removed; and N:R_4 is a radical of pyridine, quinoline, isoquinoline, or C-linked methyl homologues. The longest side chain of the nucleus R_1 shall not contain more than 8 C atoms and the number of C atoms in all these side chains shall total at least 9. The new demulsifier does not mix with the aqueous component of the emulsion while it mixes with the hydrocarbon component.

According to U.S.P. 2,429,997 the demulsifier shall comprise a compound of the formula:



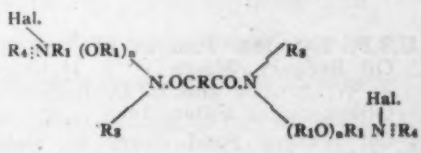
wherein, additionally, R_3 is an aldehyde residue with not more than 7 C atoms and consisting of methylene and substituted methylene radicals; R_4 consists of hydrogen or alkyl radicals with not more than 8 C atoms. The phenolic residues are substituted monocyclic and have 2 of the 3 reactive 2, 4, 6 positions substituted by 2 alkyl side chains, of which at least 1 contains 3 C atoms and the longest does not contain more than 8 C atoms.

According to U.S.P. 2,429,998 the demulsifier comprises a basic aminoalcohol ester in which the aminoalcohol radical is that of an oxyalkylated surface-active heat-polymerized aminoalcohol obtained by polymerization of the monomer

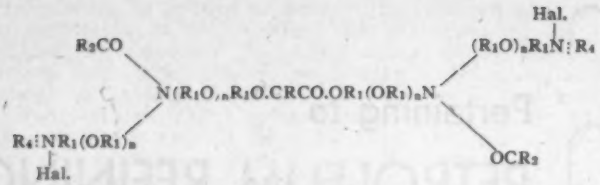


wherein OR is an alkylene oxide radical of not over 4 C atoms; R_1 is hydrogen or an alkyl radical with not more than 6 C atoms; m is a number varying from 0-3; n is 2 or 3, and n′ is O or 1, while n+n′ shall be 3. The radical introduced by oxyalkylation shall be a repetitious oxyalkylene radical in which the units have not over 4 C atoms. The number of these units introduced per aminoalcohol polymer shall not be in excess of the molal ratio 15:1. The acid radical of the aminoalcohol ester is the dimer obtained by polymerization of a polyene higher fatty acid or its monohydric alcohol ester.

According to U. S. P. 2,429,999 a dipyridinium compound is used as the demulsifier. This compound can be of the formula



or of a similar formula in which R_3 is replaced by the radical $HOR_1(OR_1)_n$, or the compound can be of the formula shown at top of the next page.



In these formulas OCRCO is the acyl radical of the dimer obtained by polymerization of a polyene higher fatty acid or its monohydric alcohol ester; R_1O corresponds to RO in the formula of U.S.P. 2,429,996; while R_3CO corresponds approximately to OC.R_6 of that formula; R_6 is a hydrocarbon radical with not more than 7 C atoms; and R_4:N corresponds to the same group of that formula.

According to U.S.P. 2,430,000 the formula of the compound to be used as the emulsifier differs from that of the compound described in U.S. patent 2,429,997 only in that one of the two symmetrically arranged groups $O(OR_2)_nCO.R_3.N(Hal).R_4$ is replaced by OR_9, wherein R_9 is halogen, a $(R_2O)_nH$ radical, or a $(R_2O)_nOCR_8$ radical, R_8CO being the acyl radical of a monocarboxy acid with not more than 7 C atoms.

According to U.S.P. 2,430,001 the group OR_9 in the formula for the compound according to U.S. patent 2,430,000 is replaced by $O(R_2O)_nOCR_7$ wherein R_7CO is the acyl radical of a monocarboxy detergent-forming acid with 8-32 C atoms.

According to U.S.P. 2,430,002 the demulsifier is a surface-active hydrophile compound of the formula R-R_5-R in which R is either

$R_1O(R_2O)_nH$ or $R_1O(R_2O)_nOCR_6$.

The significance of R_5, R_1 and R_2O is about the same as in U.S. patents 2,429,-996-7; n is a whole number of 1-60; R_6CO is the acyl radical of a low molal monocarboxy acid with not more than 7 C atoms, at least 1 polyglycol radical with at least 8 ether linkages being present.

According to U.S.P. 2,430,003 the formula of the demulsifier to be used differs from that of the demulsifier of U.S.P. 2,430,002 only in that the member R can also have the significance of $R_1O(R_2O)_nOCR_7$ wherein OCR_7 is an acyl radical of a detergent-forming acid with 8-32C atoms. At least one of the 2 members R of the basic formula shall be the radical R_7CO.

U.S.P. 2,430,182. Process of Treating Oil Refinery Waste. P. J. McGuire, F. W. Brittain and E. D. Rollins to Oliver United Filters Inc.

Oil refinery pond slurry or waste sludge is mixed with an oil of about the same characteristics as the oil contained in the slurry in an amount sufficient to produce a smooth creamy mass substantially free of lumps. This mass is subjected to the action of a continuous rotary drum precoat filter. The resulting filtrate is settled to stratify its free oil and water content.

U.S.P. 2,430,395. Process of Separating Geometric Isomers of Piperylene from each other. F. E. Frey to Phillips Petroleum Company.

A mixture of high-boiling piperylene is treated with SO_2 in a first reaction step till at least 50 percent but not more than 90 percent of the equilibrium amount of the low-boiling piperylene has been selectively converted to the monosulfone. This reaction product is separated from unreacted piperylenes. The latter are treated with SO_2 in a second reaction step to about the same extent as in the first step. The monosulfone thus obtained is separated from the unreacted piperylene which by this two-fold selective treatment is enriched in high-boiling piperylene.

CATALYST PREPARATION, ACTIVATION AND REGENERATION

U.S.P. 2,428,798 Hydrocarbon Conversion in Presence of Gel Catalysts. C. I. Glassbrook and R. C. Hansford to Socony-Vacuum Oil Company, Inc.

A catalyst is produced by subjecting an inorganic oxide hydrosol capable of setting to a gel, such as a silica-alumina hydrosol, to a unidirectional electric field of orientation, e.g. an electrostatic or electromagnetic field, during its period of gelation, washing and drying the gel. This catalyst is used for the conversion of hydrocarbons. It has an improved catalytic activity and improved mechanical strength.

U.S.P. 2,428,910. Preparation of a Porous Aluminum Chloride Catalyst. A. L. Foster to Phillips Petroleum Company.

Particulate solid $AlCl_3$ is mixed with particles of a normally solid substance that is inert with respect to $AlCl_3$, is not miscible with $AlCl_3$ in the molten state and has a m.p. and a volatilization point below about 325° F., such as ammonium carbonate or acetate. The mixture is formed into molded coherent masses of the desired shape and thereafter heated at a temperature below 325° F. but sufficiently high to volatilize the normally solid volatile substance and for such a period that this substance is completely volatilized. Porous masses of $AlCl_3$ are left which have substantially the same form as the originally molded masses.

U.S.P. 2,429,147. Production of Dihydroxyfluoboric Acid. W. E. White to Aluminum Company of America.

Dihydroxyfluoboric acid, $HB(OH)_2F_2$, which can be used as a catalyst, is produced by mixing water, boric acid or boric oxide, and a fluorine compound, an excess of water over the amount required for the formation of the product being avoided. The fluorine compound used can, for example, be boron trifluoride, fluoboric acid, or hydrofluoric acid.

U.S.P. 2,429,232. Supported Aluminum Chloride Catalyst. J. W. Latchum, A. D. Pickett, and G. B. Evans to Phillips Petroleum Company.

The catalyst material according to this patent consists of $AlCl_3$ supported on the surfaces of the granules of a carrier which consists of a granular chloride of a metal of the left-hand column of group I of the periodic system, such as NaCl. 1-40 percent of $AlCl_3$ based on the weight of the granular chloride can be used. The particles of the $AlCl_3$ shall not be mixed to any considerable degree with the granules of the other chloride. The catalyst material is said to be highly efficient in the isomerization of n-paraffins.

U.S.P. 2,429,247. Method and Apparatus for Fluid Catalytic Conversion. E. M. Van Dornick to Foster Wheeler Corporation.

A catalyst used in a catalytic conversion process is recovered by vaporizing in catalyst containing flue gas from a catalyst regeneration zone a liquid produced in a fractionating zone from a composite liquid. The mixture of vapors and flue gases is passed to a cooling and scrubbing zone where it is cooled and scrubbed with composite liquid to be catalytically converted. Liquid droplets are formed from the vapor in the cooling and scrubbing zone, and these droplets act as agglomerating nuclei for the catalyst entrained in the flue gases.

U.S.P. 2,429,319. Method of Producing Easily Pulverized Xerogel. K. K. Kearby to Standard Oil Developments Company.

A silica sol is formed from an inorganic silicate, e.g. a waterglass solution, in the presence of an alchol. An inorganic salt capable of forming a hydrous oxide is then added, and the salt is converted into the oxide. The resulting product is washed with water and dried. An easily pulverized xerogel is thus obtained. $AlCl_3$ can, for example, be employed as the inorganic salt and converted into its oxide by ammonia.

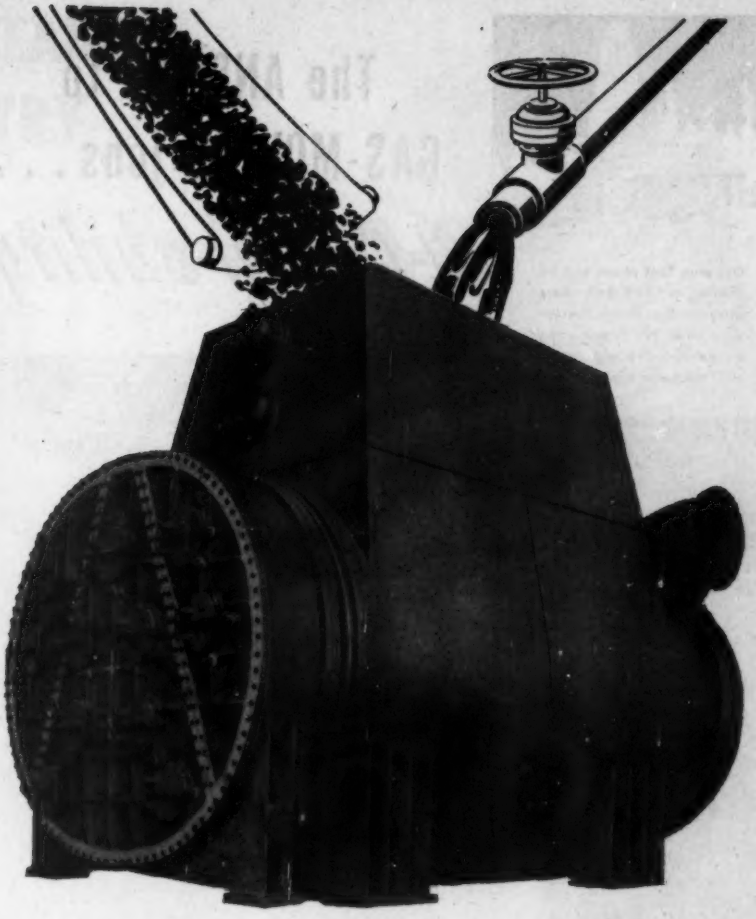
U.S.P. 2,429,855. Cobalt Amination Catalyst. J. W. Teter to Sinclair Refining Company.

The catalyst prepared according to this patent is particularly effective in selectively promoting the amination of olefins with ammonia at elevated temperatures. The catalyst consists of 40-60 percent by weight calculated as mettalic Co of reduced Co_2O_3 supported on a carrier of synthetic magnesium silicate in which the molar ratio of SiO_2:MgO is approximately 2:1. This silicate prior to the deposition of Co_2O_3 thereon has been subjected to heat treatment at 1200-1300° F. to reduce its content of volatile matter to less than 5 percent.

U.S.P. 2,429,981. Conversion of Hydrocarbons with Alkali Metal-Free Catalyst Comprising Silica and Amphoteric Oxide. J. R. Bates to Houdry Process Corporation.

Hydrocarbons are subjected at reaction temperature to the action of a pure synthetic blend of silica and alumina obtained by base exchanging a dry silica-aluminum zeolite. This zeolite is produced by drying hydrous coprecipiate of silica and alumina containing alkali metal. The base exchange is effected with a solution of an ammonium salt or an amino salt until the alkali metal content of the zeolite is completely removed. A non-volatile cation is then introduced into the zeolite by base ex-

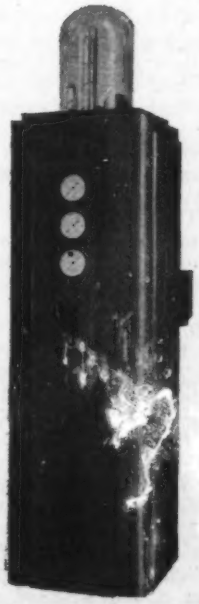
HOW MUCH FUEL DO YOUR CONDENSERS "BURN"?



Sounds like a foolish question, doesn't it? Actually it isn't—here's why: Every fraction of an inch of condenser back-pressure uses up fuel which costs you money but gives you no return, so in effect that fuel is burned up in the condenser and goes to waste—a total, and often unnecessary, loss.

The loss is unnecessary because condenser back-pressure is the result of lowered heat transfer and most transfer difficulties are due to micro-biological slime deposits on water-side surfaces.

These deposits can be economically eliminated—as has been proved in hundreds of installations—by chlorination properly applied to the cooling-water circuit. And, in addition to fuel savings, you'll gain these extra advantages, too: reduced labor costs, lower cooling water pumpage expense and less equipment out-of-service time.



Whether you use fresh, salt or brackish water and regardless of the type of cooling-water system, W&T Engineers with over thirty years' experience in water treatment will be able to show you a job-engineered W&T De-Sliming System for your plant that can save you money—often enough to pay for itself in less than a year on fuel savings alone. Why not call for an engineering study? No obligation, of course.

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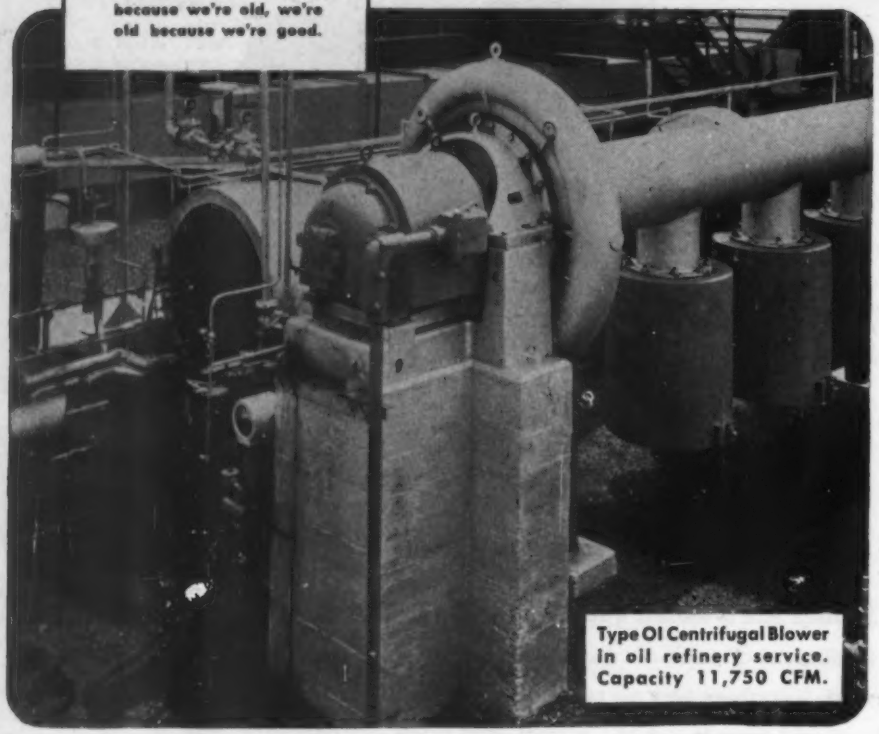

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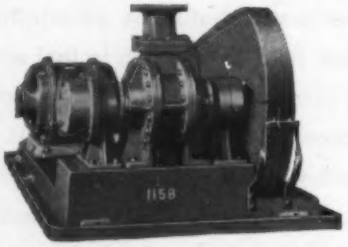

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change and treatment at high temperature to drive off residual ammonium or amino cation. Other amphoteric oxides, such as zirconia or beryllia, can be used beside or instead of alumina. The new catalyst has high activity in the transformation of hydrocarbons, e.g. in the production of gasoline from higher boiling hydrocarbons, of stable motor fuel of improved antiknock rating from naptha, and the like.

U.S.P. 2,430,015. Utilization of Powdered Catalysts. J. A. Hatton, D. L. Cleveland, and N. E. Peery to Shell Development Company.

A representative portion of a finely divided adsorptive solid catalyst which declines in activity and adsorptive ability in use (e.g. siliceous cracking catalyst) is continuously withdrawn from the main mass of catalyst and separated by an electrostatic separation treatment into two fractions of different specific surfaces. The fraction of lower spec. surface is discarded while that of higher spec. surface is returned to the main mass. A portion of fresh catalyst equivalent to the discarded fraction is added to the main mass.

U.S.P. 2,430,289. Process for Ammoniating an Acid Treated Clay. W. W. Gary to Filtrol Corporation.

An acid activatable clay, such as bentonite, is treated with acid to extract alumina. The clay separated from the acid should have a titratable acidity of 140 mg. of KOH per gram of clay or less. This clay is contacted with gaseous NH_3 at a temperature sufficiently high to dry the clay but not to drive off the NH_3. The clay is thus brought to a lower titratable acidity and a material of pH of about 4-9 is obtained. The Catalytic activity of the clay, particularly for the cracking of hydrocarbons, is considerably improved by the ammonia treatment.

CRACKING AND REFORMING

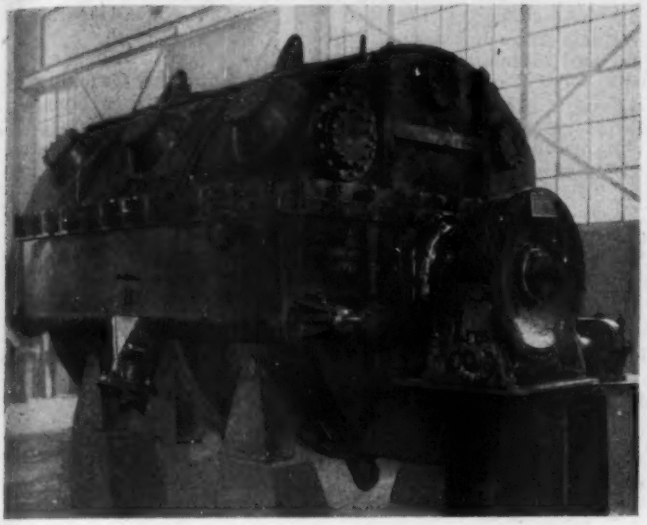
U.S.P. 2,429,127. Treating Hydrocarbon Fluids. J. M. Graham, E. J. Gohr, and C. W. Tyson to Standard Oil Development Company.

In a hydrocarbon conversion process using powdered catalyst in a cracking step and in a hydrocarbon product retreating step, the retreated vapors are scrubbed with a relatively heavy oil to remove entrained catalyst in slurry form. At least part of the slurry is used to supply make-up catalyst to the cracking step by passing the slurry to a regeneration zone used for regenerating fouled catalyst resulting from the cracking step. The retreatment improves the octane number of the catalytically cracked material, e.g. gasoline, so that it may be used as an aviation gasoline.

U.S.P. 2,429,161. Control of Catalytic Processes Using Mobile Catalysts. T. B. Hudson to Phillips Petroleum Company.

In an endothermic catalytic conversion process, such as cracking of hydrocarbons, the vaporized hydrocarbons are passed through an elongated reaction zone, under such conditions of temperature and pressure that the temperature decreases in the direction of flow. Powdered solid catalyst is introduced into this zone at a plurality of points for

PIONEER and STILL LEADER in the OIL INDUSTRY



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Write for Bulletin 201 describing filters and other equipment for the petroleum refiner.

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suspension in the vapors. Conversion products are separated from the effluents. Insufficiently converted hydrocarbons are recycled. A portion of the catalyst separated from the effluent is reactivated while the remainder thereof is recycled without reactivation to a plurality of the introducing points including the first and excluding the last of them in the direction of the flow. While this unreactivated catalyst only is introduced to the first point, a diminishing quantity of it is introduced at each succeeding point. The reactivated portion of the catalyst is introduced correspondingly in increasing quantities from the second to the last point, so that an increasing catalytic activity is maintained in the direction of flow thereby establishing a constant rate of reaction throughout the reaction zone despite the decreasing temperature, normally decreasing catalyst activity, and decreasing concentration of reactants.

U.S.P. 2,429,566. Cracking of Olefins. F. O. Rice.

Olefins are passed through a cracking zone at cracking temperature under a sub-atmospheric pressure and at a rate correlated to maintain a condition just short of that at which a visible amount of tar, liquid, or carbon is present in the reaction products. For example, isobutylene was passed through a quartz tube about 1 inch in diameter and 10 inches long at 773° C. under a pressure of 1/7 atm. and at a rate of flow such that the contact time of the olefin with the heated tube was 0.46 seconds. No formation of tar, liquid, C, or smoke was then visible. For each mol. of isobutylene there was obtained 0.21 mol. of allene together with 0.38 mol. of methyl acetylene.

U.S.P. 2,429,718. Process for Producing Aviation Gasoline. C. T. Harding to Standard Oil Development Company.

A heavy naphtha in the boiling range of about 200-410° F. is severely thermally cracked in a single stage at a temperature of 1200-1400° F. to convert substantially all of the paraffins and naphthenes into aromatic hydrocarbons including benzene, toluene and xylenes admixed with olefins containing a large amount of ethylene and some diolefins. An aromatic fraction consisting essentially of aromatic hydrocarbons in the aviation gasoline boiling range and ethylene is separated from the cracked products. The separated ethylene is catalytically alkylated with isobutane to form a hydrocarbon fraction rich in 2, 3 dimethyl butane. At least part of the separated aromatic fraction is blended with the alkylated hydrocarbon fraction to form an aviation gasoline blending stock. The isobutane used in the alkylating step can be separated from the heavy naphtha before its thermal cracking.

U.S.P. 2,429,854. Catalytic Cracking of Hydrocarbon Oils to Produce Gasoline. J. W. Teter to Sinclair Refining Company.

A substantially liquid body of oil to be cracked at a moderate cracking temperature is heated in a vertically elongated cracking zone containing superposed baffling means adapted to distribute dispersed upwardly flowing gaseous products and to impede the downward flow of suspended solids. A finely divided argillaceous catalyst dispersed in oil to be cracked is supplied to the upper end of the cracking zone. Gaseous products are injected into the lower part of this zone. Cracked vapors and gases are taken off from the upper end of the zone. Residual oil and admixed spent catalyst are withdrawn from the lower end of the zone. Fresh charging oil is supplied to a lower portion of the zone to contact with partially spent catalyst therein. The gaseous products are supplied to produce agitation and maintain the catalyst in suspension. They may comprise either an inert gas or a more or less reactive one, or a mixture of the two. Gaseous hydrocarbons produced in the process can also be employed for this purpose.

U.S.P. 2,429,875. Production of Gasoline and Diesel Fuel by Catalytic Cracking and Solvent Extraction. G. M. Good, H. H. Voge, and B. S. Greensfelder to Shell Development Company.

Hydrocarbon oils boiling above the gasoline boiling range are catalytically cracked under conditions to produce a substantial quantity of olefinic gasoline which is separated as a fraction from the product together with a catalytic gas oil fraction. The latter fraction is separated into a hydrogen-rich Diesel fuel fraction and a hydrogen-poor fraction (extract) by means of solvent extraction. The extract is hydrogenated and the product thereby obtained is mixed with the olefinic gasoline fraction. This mixture is again catalytically cracked and the product of this cracking step is separated into a gasoline fraction and a gas oil fraction. Quality gasoline and quality Diesel fuel are thus produced simultaneously.

U.S.P. 2,430,096. Plural Stage Catalytic and Thermal Conversion of Hydrocarbons. W. H. Barcus to Sun Oil Company.

A composite, higher boiling hydrocarbon charge, such as a straight-run gas oil obtained from Gulf Coastal and East Texas crudes, is catalytically cracked. A fraction with at least 25 percent of high boiling aromatics is selected from the reaction products and thermally cracked. A fraction with at least 40 percent of high boiling aromatics and a minor percentage of olefins is selected from the resulting reaction products and treated in an independent zone in the presence of a cracking catalyst to transform high boiling to lower boiling aromatics and reduce the olefin content. A fraction containing at least 65 percent of lower boiling aromatics is separated from the resulting mixture as the desired product.

U.S.P. 2,430,245. Method for Continuous Catalytic Operation. J. W. Payne to Socony-Vacuum Oil Company, Inc.

Active particles of a solid cracking catalyst are flown through a cracking zone in direct contact with a stream of heavy petroleum reactant under cracking conditions. Spent catalyst withdrawn from this zone is passed into a regeneration zone and regenerated therein while suspended in a stream of air which is restricted to a cross-section of less than about 6 inches in at least one transverse dimension. A sufficient amount of liquid heat exchange medium maintained at a suitable regenerating temperature below 1050° F. is circulated within a distance of not more than 3 inches from all catalyst particles in the regenerating zone but out of direct contact with them, so that the desired regenerating temperature is maintained. Regenerated catalyst is returned to the cracking zone without permitting the catalyst to cool to atmospheric temperature. Petroleum reactant is prevented from passing into the regenerating zone and air from passing into the cracking zone. Gasoline is obtained.

U.S.P. 2,430,249. Catalytic Cracking of Partially Oxidized Hydrocarbons. R. F. Ruthruff.

Mineral oil is cracked in the presence of a silica base catalyst and in the absence of added oxygen to convert a part of the oil into gasoline type motor fuel. The lighter gasoline portion is removed by fractionation of the product. A heavier fraction is then partially oxidized under conditions which result in a material percentage of oxygen derivatives of hydrocarbons being formed. The resulting materials is recracked to produce further amounts of gasoline-type motor fuel.

U.S.P. 2,430,344. Preheater for Oil for Refinery Crackers. W. W. Kemp to The C. M. Kemp Manufacturing Company.

A system for preheating petroleum oils to be cracked is described. Heating fuel is completely combusted and the combustion process is used to provide circulation of hot combustion gases.

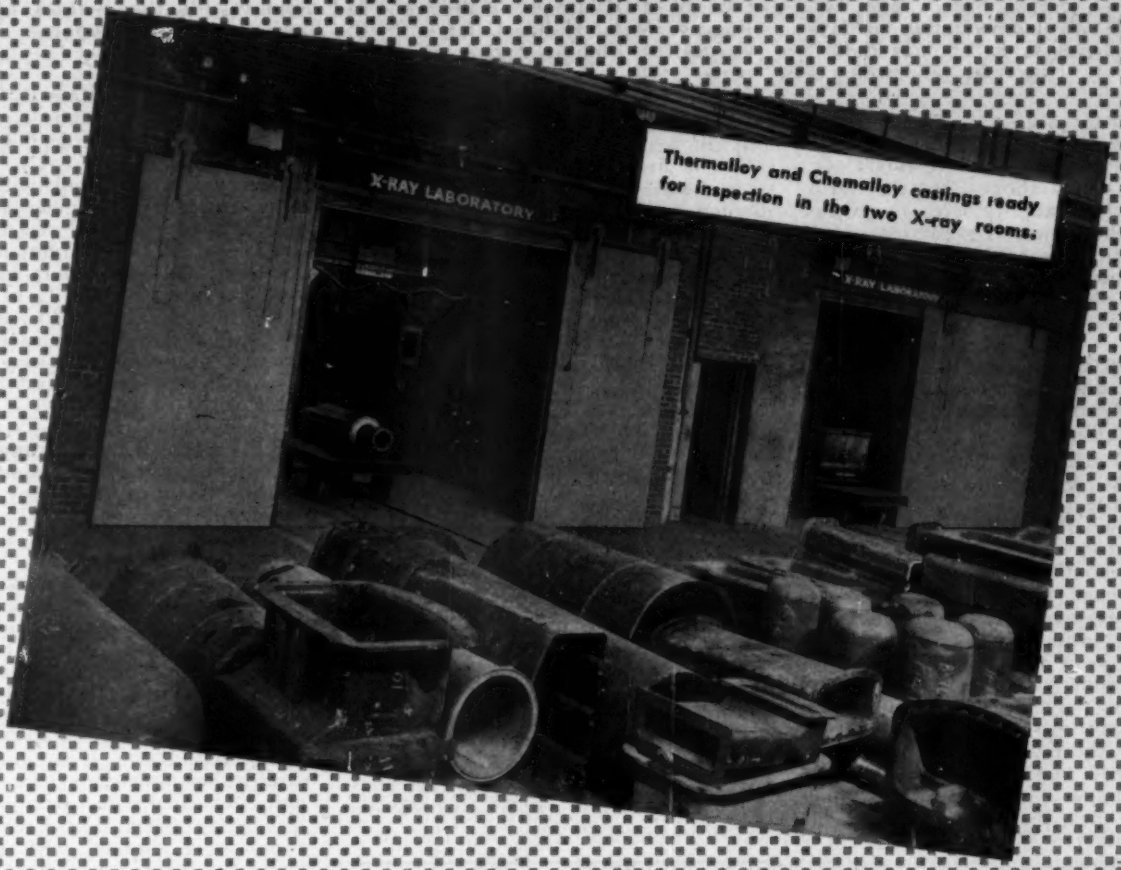
ISOMERIZATION

U.S.P. 2,428,841. Production of Branched **Chain Alkanes.** E. W. M. Fawcett and G. I. Jenkins to Anglo-Iranian Oil Company, Ltd.

A bed of solid aluminum halide is arranged in the upper portion of an isomerization reaction vessel, while a bed of adsorptive medium of high available surface area is arranged subjacent to the first-named bed in the vessel. The adsorption bed is maintained at a relatively low isomerizing temperature at least equal to the temperature of the aluminum halide bed. An n-alkane feed stock containing a small proportion of hydrogen halide is flown downwardly through the vessel over both beds. Fresh additional solid aluminum halide is deposited on the first-named bed as the aluminum halide is consumed. Branched chain alkanes are obtained, e.g. isobutane from n-butane.

U.S.P. 2,428,883. Removal of Hydrogen Halide from a Gaseous Effluent of an Isomerization Process. H. H. Lee to Phillips Petroleum Co.

Isomerization of a hydrocarbon, such as n-butane, is carried out by means of $AlCl_3$ on an adsorptive carrier, promoted by HCl. A normally gaseous mixture of HCl and paraffin hydrocarbons is withdrawn from the reaction mixture and passed through a body of metallic Al having an extended surface. The HCl is thus removed from the gaseous mixture under formation of $AlCl_3$ which is retained in solid form in the body of mettalic Al. The flow of the mixture through this body is periodically discontinued, and the $AlCl_3$ is sublimed therefrom by passing a stream of hot incoming hydrocarbon vapors therethrough and then into the reaction zone



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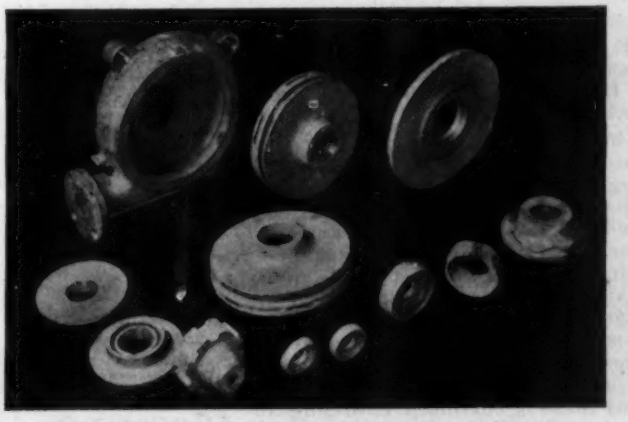

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U.S.P. 2,428,923. Isomerization of Hydronapthalenes. C. L. Thomas and H. S. Bloch to Universal Oil Products Company.

Tetrahydronapthalene (tetralin) or decahydronapthalene (decalin) are subjected at a temperature of 300-600° C., a pressure below about 100 psi., and a liquid hourly space velocity in excess of -.25 to the action of a catalyst comprising a fluoride of Al, Zr, Mg, Th, or B. Methylindane or isodecalin, respectively, are obtained as products of the isomerization reaction.

U.S.P. 2,428,981. Method for Removing Metal Halide Vapors from a Hydrocarbon Reaction Product. C. O. Meyers to Phillips Petroleum Company.

A stream of low boiling hydrocarbons is passed in contact with a volatilizable Friedel-Crafts type catalyst under suitable conditions for conversion at which simultaneously some of the metal halide catalyst becomes incorporated in the effluent stream. This incorporated metal halide is then removed from the effluent stream by intimately countercurrently contacting it in vapor phase in a first scrubbing zone with metal halide complex olefinic polymer sludge withdrawn from the bottom of this zone and reintroduced thereto. The major part of the entrained metal halide is absorbed by this sludge. The remaining effluent stream is then intimately counter-currently contacted in vapor phase in a second scrubbing zone with fresh liquid olefinic polymer whereby the remainder of the entrained metal halide is absorbed. The effluent stream thus freed from metal halide is recovered while the olefinic polymer withdrawn from the second scrubbing zone is introduced to the first zone and employed therein with the recirculated sludge for the scrubbing step. The process can, for example, be employed for the isomerization of n-butane.

U.S.P. 2,429,125. Catalytic Process for Treating Hydrocarbons with a Metallic Halide. O. Gerbes to Standard Oil Development Company.

A hydrocarbon feed stock is passed upwardly in superheated vaporous state through a porous mass, such as bauxite, the lower portion of which contains deposited metallic halide. At least a portion of the feed stock shall be capable of reacting with the metallic halide under formation of sludge. The sludge forming reactants are impurities contained in the feed stock, such as olefins or hydrocarbons heavier than the fresh feed. The flow of feed stock through the adsorbent porous mass is continued until substantial amounts of sludge are formed in the lower, metallic halide containing portion of the mass. Additional metallic halide is introduced into a portion of the mass where no metallic halide was deposited before. Feed stock in vaporous form is then passed through the portion of the mass in which sludge has been formed and then through that portion which contains the additional metallic halide. The sludge forming impurities are thus removed prior to contact with the later introduced portion of the metallic halide catalyst. The process is particularly employed in the isomerization of paraffins, e.g. n-butane.

U.S.P. 2,429,218. Process for Effecting Hydrocarbon Conversion in the Presence of a Hydrogen Halide and a Fugitive Metal Halide Catalyst. S. C. Carney to Phillips Petroleum Company.

Hydrocarbon is passed together with an activating amount of HCl through a first and a second bed of a solid adsorbent. The first bed has a Friedel-Crafts type metal halide catalyst adsorbed thereon while the second bed is unsaturated with respect to this metal halide. During the flow of the hydrocarbon-HCl mixture under conversion conditions through these two beds metal halide is passed from the first to the second bed. The HCl content of the feed to the first bed is increased while a constant activating HCl content is maintained in the feed to the second bed by introducing hydrocarbon intermediate both beds. The increase in HCl for the first bed is maintained until it is freed of a substantial proportion of its metal halide. Hydrocarbon with normal content of HCl is then flown first through the second bed and then through the first bed under such conversion conditions, that metal halide passes from the second to the first bed. For this purpose the HCl content of the feed to the second bed is increased and hydrocarbon is introduced between the second and the first bed in a manner corresponding to that of the the first part of the process. Isomerization of saturated hydrocarbons, e.g. of n-butane, in vapor phase can, for example, be effected by this process.

ALKYLATION

U.S.P. 2,429,205. Alkylation of Isoparaffins, by means of Olefins. F. J. Jenny, M. M. Perkins, and M. J. Cicalese to The M. W. Kellogg Company.

A low-boiling mixture of hydrocarbons comprising an isoparaffin, the corresponding n-paraffin, and low-boiling olefins capable of alkylating the isoparaffin in substantial excess of that amount necesary to alkylate all of the isoparaffin is subjected first to an isomerization treatment (to isomerize the olefins in order to increase the proportion of higher-boiling olefins) and then, after separation of a low-boiling fraction, to catalytic alkylation. A fraction comprising unreacted isoparaffins and a fraction containing the higher-boiling n-paraffins are separated from the alkylation products. A portion of the lower-boiling fraction separated before is introduced directly into the zone of fractionation of the alkylation products while the remainder is introduced into the alkylation reaction zone.

U.S.P. 2,429,575. Synthesis of Branched Chain Hydrocarbons. W. G. Appleby, L. L. Lovell, and M. P. L. Love to Shell Development Company.

Thiophene or an alkyl-substituted thiophene is reacted with an olefin at alkylating conditions in the presence of an alkylating catalyst. At least a part of the reaction products is hydrogenated in the presence of a suitable catalyst and of added hydrogen. Branched chain hydrocarbons, such as 2, 2, 3- trimethylpentane and 2, 2-dimethylhexane, are obtained. The alkylation can be carried out at a temperature of 200-400° C. and the hydrogenation at 275-450° C. The hydrogenation catalyst can comprise a sulfide of a heavy metal. Removal of the S-atom occurs with opening of the thiophene ring during hydrogenation.

U.S.P. 2,429,691. Meta-Di-Tert-Butylbenzene. C. E. Johnson and C. E. Adams to Standard Oil Company (Indiana).

Benzene is alkylated with 2 molar equivalents of isobutylene in the presence of $AlCl_3$ and HCl at a temperature of at least 130° F. A fraction consisting essentially of m-di-tert-butylbenzene having a b.p. of 106.5° C. at a pressure of 18.2 mm Hg and 78.5° C. at a pressure of 4.4 mm. Hg is separated from the reaction products. The new compound has a m.p. of 10.6° C. and a refractory index (n_D^{20}) of 1.4870.

U.S.P. 2,429,887. Alkylating Aromatic Compounds. G. L. Magoun to Monsanto Chemical Company.

A liquid mixture of alkyl chloride and aromatic hydrocarbon, e.g. a solution of chlorinated kerosene in benzene, is passed concurrently through at least three successive stationary beds of $AlCl_3$ catalyst of increasing activity. The $AlCl_3$ is rendered stationary with respect to the adjacent portions by separating it from the liquors leaving each unit and recycling the catalyst through the same unit. Spent catalyst is intermittently withdrawn from the first unit after it is completely exhausted, and this unit is charged with partially spent catalyst from the next unit. Each unit except the last is charged with the catalyst from the next succeeding unit, while fresh catalyst is introduced into the final unit. Friedel-Crafts mono-alkylation of benzene by ethylene can also be carried out in this manner.

U.S.P. 2,430,181. Alkylation of Isoparaffinic Hydrocarbons. C. B. Linn to Universal Oil Products Company.

An isoparaffin is reacted with an olefin in the presence of a liquid HF catalyst having dissolved therein a minor proportion of an alkali metal fluoride or sulfate. The activity of the HF catalyst is accurately controlled by proper dilution with these non-aqueous substances. The catalyst can, for example, contain 10 percent KF.

U.S.P. 2,430,190. Alkylation of Phenols. L. Schmerling and V. N. Ipatieff to Universal Oil Products Company.

A phenol is alkylated with an olefin in the presence of an alkyl halide and silica or alumina. Isopropyl chloride can, for example, be employed as the alkyl halide. A temperature of 100-500° C. is employed in the alkylating reaction.

U.S.P. 2,430,228 Multistage HF Alkylation of Isoparaffins by Means of Olefins. J. B. Kirkpatrick, C. H. Schlesman, and A. A. O'Kelly to Socony-Vacuum Oil Company, Inc.

A vapor phase mixture of isoparaffins and olefins is injected as bubbles into a body of liquid HF in the first of a series of successively higher alkylation zones. Hydrocarbons are continuously transferred from above the body of liquid HF in each of these zones except the uppermost to the next higher zone by vaporizing these hydrocarbons and injecting the vapors into the body of liquid HF of this next zone. Additional hydrocarbon reactants are injected in vaporized

state with the transferred hydrocarbons. Fresh liquid HF is continuously supplied to the body thereof in the uppermost zone while liquid HF is continuously transferred from the body thereof in each zone except the lowermost to the next lower zone. From the lowermost zone liquid HF is continuously removed while liquid hydrocarbon reaction mixture is continuously removed from the series. Alkylate product is recovered from this reaction mixture. The catalyst in the reactors can, for example, be maintained at 50-60° F. and the charge to each reactor be preheated to 175° F.

U.S.P. 2,430,333 Paraffin Alkylation in the Presence of Hydrogen Fluoride. S. T. Hadden to Socony-Vacuum Oil Company, Inc.

In the catalytic alkylation of isoparaffins with olefins by means of liquid HF, fresh hydrocarbon feed is introduced below at least one tray in a reaction section of a fractionating column intermediate its upper and lower trays. Vapors are refluxed from the reaction section in a refluxing section and reflux liquid is returned to the reaction section. Liquid from the reaction section is stripped in a stripping section of the column below the reaction section and vapors are returned therefrom to the reaction section. Vapors rising in the column are baffled immediately below each tray in the reaction section to disengage liquid spray from the next lower tray. Fresh feed is mixed with the baffled vapors to produce a uniform feed mixture which is introduced as a vapor to a body of acid on said tray.

U.S.P. 2,430,212 Process for the Alkylation of Paraffin Hydrocarbons. L. A. Clarke and E. F. Pevere to The Texas Company.

Ethylene is alkylated with an isoparaffin, such as isobutane in a first step, in the presence of a freshly prepared catalyst which consists of a mobile liquid comprising the reaction product formed by contacting $AlCl_3$ and a promoter with ethylene and an isoparaffin until the catalyst becomes at least partially spent. An isoparaffin is then alkylated in a second step with a normally gaseous higher homologue of ethylene in the presence of the catalyst at least partially spent in the first step.

POLYMERIZATION AND CONVERSION

U.S.P. 2,428,872 Process and Apparatus for Contacting Solids and Gases. R. C. Gunness to Standard Oil Company (Indiana.)

Hydrocarbons to be converted are contacted with suspended solid catalyst at conversion temperature in a reaction zone where a dense turbulent catalyst phase is maintained below a relatively dilute catalyst phase. Catalyst is continuously separated within the reaction zone from the products of the reaction and maintained at the reaction temperature. The products of reaction are separately withdrawn from the reaction zone. The separated catalyst is conducted downwardly from the reaction zone in a dense aerated phase and discharged directly into a regeneration zone maintained in heat exchange with the reaction zone. The catalyst is dispersed in a dense turbulent suspended phase

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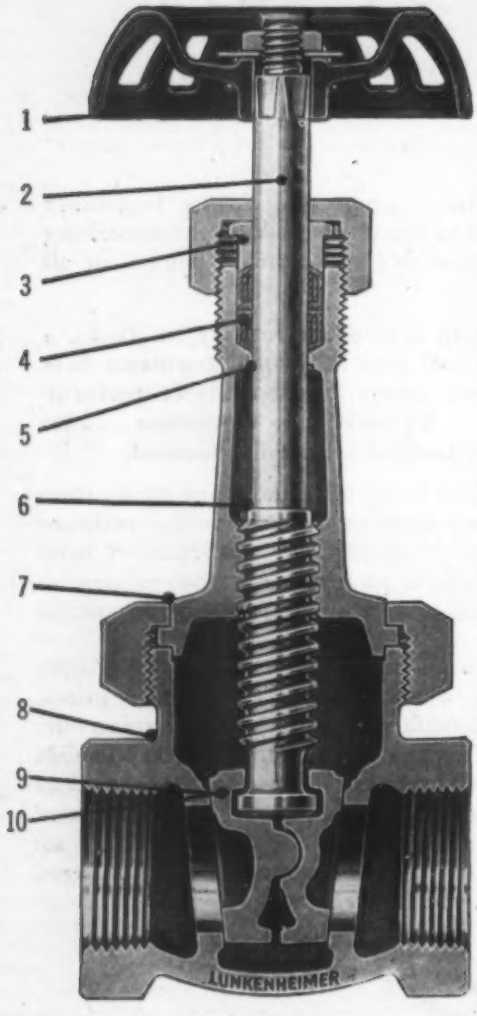

Fig. 2228

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in contact with oxygen-containing regeneration gas within the regeneration zone, is separated after regeneration from regeneration gases and accumulated in a relatively dense phase within this zone. Regenerated catalyst is withdrawn downwardly in this dense phase. Residual regeneration gases are stripped from the dense phase catalyst which is then commingled with the hydrocarbons to be converted.

U.S.P. 2,428,873 Process and Apparatus for Catalytic Contacting. R. C. Gunness and J. F. Snuggs to Standard Oil Company (Indiana).

The process of this patent is similar to that of U.S.P. 2,428,872. Improved methods and means are provided for transferring the finely divided catalyst from the reactor to the regenerator. Two contacting zones can be arranged, the one located above the other.

U.S.P. 2,428,914 Process of Effecting Exothermic Catalytic Reactions. L. S. Kassel to Universal Oil Products Company.

Hydrocarbons and a subdivided solid catalyst are passed through a reaction zone where the hydrocarbons are exothermically reacted at conversion temperature. An excessive temperature rise by the exothermic heat of reaction in the reaction zone is prevented by introducing during the reaction subdivided solid catalyst at a temperature substantially below the conversion temperature and in sufficient amount to absorb at least the major portion of the exothermic heat of reaction. The process can, for example, be employed in the polymerization or hydrogenation of hydrocarbons.

U.S.P. 2,429,359 Catalytic Conversion of Hydrocarbons. L. S. Kassel to Universal Oil Products Company.

Hydrocarbon reactants are contacted in a confined reaction zone with a compact bed of previously heated moving solid particles which comprise the catalyst and supply heat to the reactants for their endothermic conversion. The heating of the solid particles is effected during regeneration after contamination of the catalyst and the conversion conditions in the reaction zone are regulated to deposit on the solid particles an amount of combustible contaminants sufficient to store in the solid particles when burnt in the regeneration zone a quantity of heat in excess of that required in the reaction zone. This excess of heat is abstracted from the solid particles in a cooling zone separate from the reaction and regeneration zones. The temperature of these particles shall thereby be controlled so that they enter the bed of the reaction zone at a temperature not more than about 75° F. higher than the average temperature to be maintained in the bed.

U.S.P. 2,429,545 Method and Apparatus for Hydrocarbon Conversion. E. V. Bergstrom to Socony-Vacuum Oil Company, Inc.

The process relates to the conversion of fluid hydrocarbons to lower boiling gaseous hydrocarbons in the presence of a moving particle-form solid catalyst arranged as three superposed compact beds within a confined zone. A gas space is formed above each bed. Fresh catalyst and fluid hydrocarbon charge are supplied to the uppermost bed. The gaseous

hydrocarbons formed by conversion in this bed are withdrawn together with used catalyst from the bottom of this bed as a plurality of confined streams distributed across the cross-section of the bed and directed through the gas space over the intermediate bed. The gaseous products are thus caused to disengage from the admixed catalyst on the surface of this bed and pass as a plurality of horizontally spaced streams through this intermediate bed into the gas space of the lowermost bed, where the treatment is similar to that previously described. Used contact material is uniformly withdrawn from all portions of the cross-section area of this lowermost bed at such a rate that continuity of compact catalyst material is maintained throughout the entire length of the confined zone.

U.S.P. 2,429,719 Production of Unsaturated Dimers of Alpha Alkyl Styrenes. A. B. Hersberger and R. G. Heiligmann to The Atlantic Refining Company.

An alpha alkyl styrene, e.g., alpha methyl styrene, is intimately contacted with H_2SO_4 of 30-65 percent concentration at a temperature of 150-220° F. The resulting unsaturated dimer is separated from the H_2SO_4.

U.S.P. 2,429,721 Contacting Gases and Solids in Fluidized Systems. C. E. Jahnig to Standard Oil Development Company.

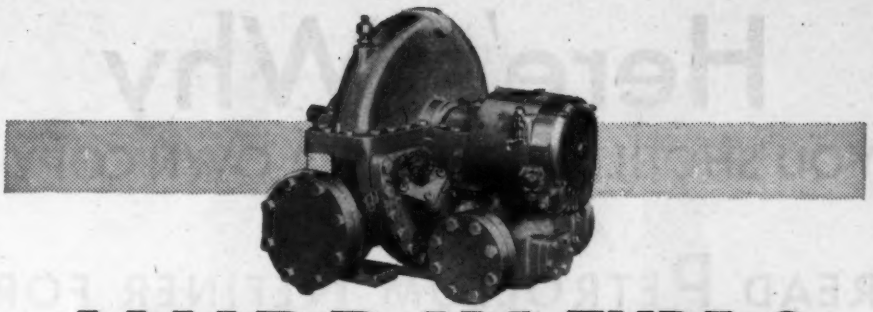
A gaseous fluid, e.g., gaseous hydrocarbons, and solid particles of catalyst, or the like, are introduced into a contacting zone where the particles are maintained in fluidized condition. Solid particles are then withdrawn from the bottom portion of this zone while gaseous fluid is passed overhead from this zone. Portions of withdrawn solid particles are mixed with separate streams of regenerating gas, and these separate streams are passed to separate regeneration vessels arranged one above the other in the same housing which contains the contacting zone. Solid particles are passed from an upper to a lower regeneration zone and then to the contacting zone.

U.S.P. 2,429,751 Separation of Gases from Solid Particles. E. J. Gohr and R. W. Richardson to Standard Oil Development Company.

Solid particles, particularly such of a catalytic nature are introduced into a contacting zone. Gaseous fluid or reactant vapor is introduced into the bottom portion of this zone and passed upwardly through it at a velocity of 0.5-8.0 feet per second depending on average particle size to maintain the solid particles in a dense fluidized liquid-simulating phase. Above the level of this dense fluidized phase is a less dense suspended particle phase. Fluidized solid particles are withdrawn directly from the dense phase. Gaseous fluid or vapors are conducted from this dense fluidized phase through the openings of a filter element arranged to extend into the dense fluidized phase in the contacting zone and are thus obtained free of solid particles. The losses of finely divided solid are reduced by this process.

U.S.P. 2,429,980 Process of Conducting Chemical Reactions. J. J. Allinson to Lion Oil Company.

An aeriform mixture of air, steam and



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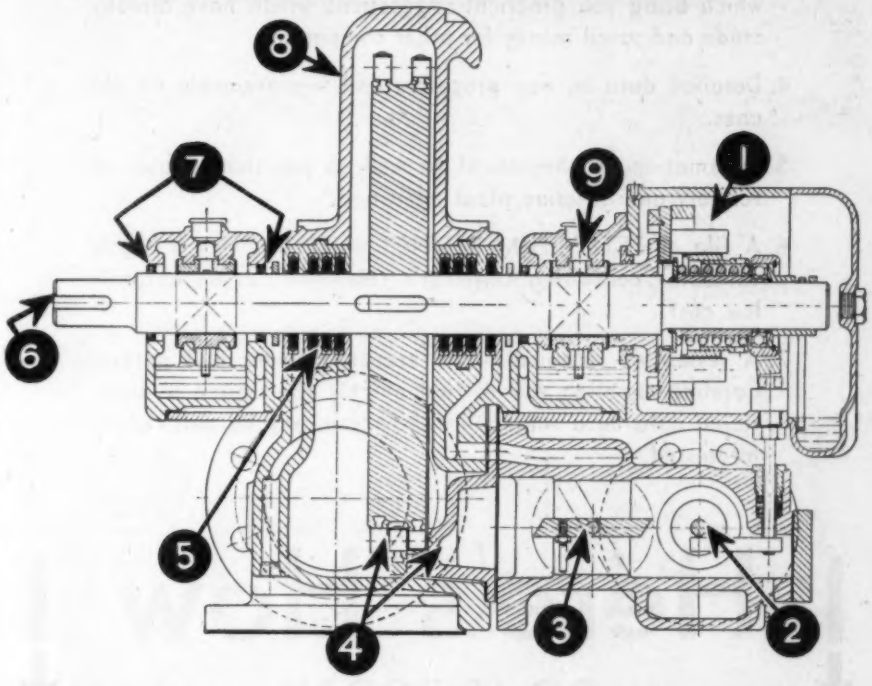

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hydrocarbon is passed at a temperature of 100-900° C. from within a confined upright, annular, loosely packed column of small-size solids radially outwardly therethrough and in intimate contact therewith to cause chemical reactions. The stream of reaction products is immediately cooled by contact with a cooled solid surface. The amount of air employed shall be insufficient for the complete combustion of the hydrocarbons. The solid particles are passed continuously downwardly with a free-flowing tumbling motion over a zig-zag course at a rate sufficient to keep the bed pervious to the passage of the aeriform fluid. The process can be used for hydration, dehydration, cracking, polymerization, and depolymerization reactions.

U.S.P. 2,430,420 Apparatus for Contacting Gases with Moving Particle Form Solid Material. L. P. Evans to Socony-Vacuum Oil Company, Inc.

The apparatus for converting gaseous hydrocarbons in the presence of particle form solid contact material has a plurality of vertical foraminate partitions arranged in a closed reaction vessel to provide separate gas inlet distribution and gas outlet collecting spaces and means to prevent flow of solid material into these spaces. The invention is concerned with a particular construction of the foraminate partitions.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,429,115 Hydrogenation Process and Apparatus. G. T. Atkins to Standard Oil Development Company.

In subjecting hydrocarbons to an exothermic reaction, particularly to hydrogenation, the reaction material itself is utilized to control the temperature in the reaction zone. For this purpose, raw hydrocarbon feed is introduced to a separating zone and the bottoms from this zone are fed through the reaction zone in indirect heat exchange relation with the reactants. The said bottoms are then reintroduced into the separation zone, and a fraction from this separation zone is recovered and fed into the reaction zone to be subjected to the exothermic reaction.

HEAVY OILS AND WAXES

U.S.P. 2,429,150 Petroleum Wax Coating Composition. J. C. Zimmer and E. W. Carlson to Standard Oil Development Company.

The composition according to this patent comprises 10-70 percent paraffin wax, 20-80 percent petrolatum, and 1-8 percent of a lead soap of saturated fatty acids of 12-24 C atoms, e.g., of hydrogenated fish oil acids. The composition is useful, for example, as a coating for wooden, paper, or fibre containers, for protecting metals, and the like.

U.S.P. 2,429,198 Cutting Oil Composition. L. H. Sudholz and C. D. Flemming to Socony-Vacuum Oil Company, Inc.

The cutting oil composition according to this patent comprises a mineral lubricating oils, a sulfurized tall oil, and 5-

30 percent of a hydrocarbon oil having an aniline point of + 40° F. or lower, a sp. gr. of 0.9-1.06, a flash point of 250° F. minimum, an initial b. p. of not less than 450° F., and a viscosity of not over 200 seconds Saybolt Universal at 100° F. The addition of this hydrocarbon solvent inhibits the separation of sludge.

U.S.P. 2,429,430 Wax-Oil Separation. A. H. Schutte.

An oil-wax mixture is emulsified with a non-solvent liquid having a freezing point above the pour point of the wax-free oil and having a crystal formation when frozen, and with an oil-selective diluent in a liquid state, of greater sp. gr. than the wax of the mixture and heavier than the frozen non-solvent and having a lower freezing point than the latter. The resulting emulsion is chilled to freeze the non-solvent and precipitate the wax while oil and diluent remain in liquid state. The chilled emulsion is centrifuged to separate the wax and form annular concentric strata including an inner stratum of separated wax and crystals of the frozen non-solvent and an outer stratum comprising a solution of oil and diluent. This outer stratum is maintained relatively deep radially during the centrifuging, thereby maintaining sufficient residence time of the materials within the centrifuging step to permit separation of the frozen non-solvent from the oil and diluent solution and to permit combining of cloud-forming particles from the solution with crystals of frozen non-solvent in their passage radially inward from the solution. The process is particularly designed for the dewaxing of petroleum oils. Water can be used as the non-solvent and monochlorobenzene or dichlorodifluoromethane as the diluent.

U.S.P. 2,429,479 Lubricating Oil Compositions Containing Wax Modifying Agents. L. A. Mikeska to Standard Oil Development Company.

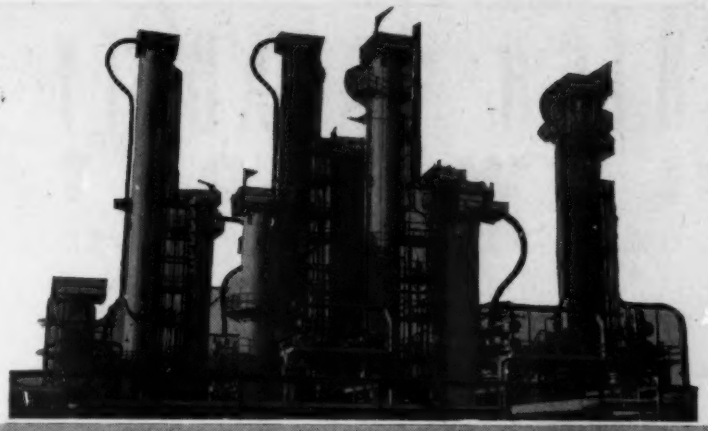
The lubricating oil composition according to this patent comprises a wax-containing mineral oil and an amount sufficient to reduce the pour point but not in excess of 5 percent of a product obtained by reacting aromatic hydrocarbons with formaldehyde or its polymers in the presence of H_2SO_4 as a catalyst to produce a formaldehyde-cyclic resinous material which is then acylated in the presence of a Friedel-Crafts catalyst with an acylating agent whose acyl groups contain at least 6 C atoms per molecule, such as stearyl chloride.

U.S.P. 2,429,727 Refining Waxes. R. A. Macke and H. J. Zoeller to Standard Oil Development Company.

A wax containing petroleum oil is treated to segregate oily wax therefrom. The wax is de-oiled by means of a solvent to obtain an at least partially de-oiled wax. The wax is then distilled over excess alkali. The refined wax thus obtained has desired heat stability and light stability characteristics.

U.S.P. 2,429,735 Lubricating, Rust-Dissolving, and Penetrating Oil. H. J. Vuyk.

The liquid according to this patent consists of an intimate mixture of CCl_4, acetic acid, gas oil and a lubricating oil in a proportion by volume of about 3:1:2:4. The liquid serves for releasing "frozen" ferrous metallic threaded joints



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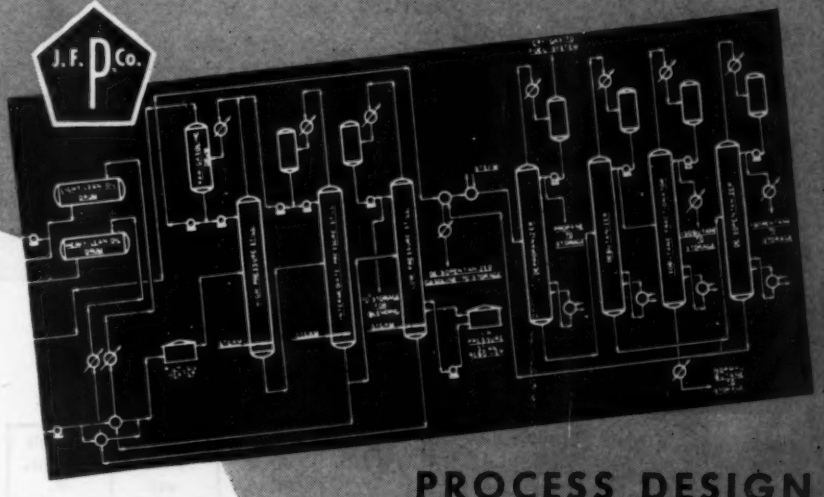

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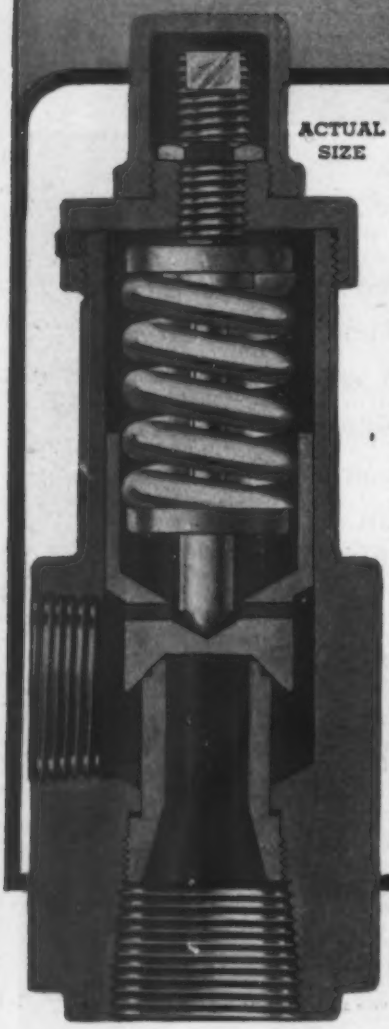

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¾	0.077 0.019	2000 10000	5¼
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U.S.P. 2,429,905 Lubricant Composition. W. A. Wright to Sun Oil Company.

The lubricant composition according to this patent consists essentially of lubricating oil and 0.1-2.0 percent of an oil-soluble, water-insoluble 1,2 dihydroxybenzene having an alkyl group attached to the benzene ring, viz. 4-tertiary butyl-1,2 benzenediol, 4-tertiary octyl-1,2 benzenediol, 4-lauryl-1,2 benzenediol, or 4-cyclohexyl-1,2 benzenediol. This lubricant is adapted for use under service conditions in the presence of water and prevents rusting by contact of metal with water.

U.S.P. 2,430,039 Oil Base Drilling Fluid. F. M. Anderson to Halliburton Oil Well Cementing Company.

The oil base drilling fluid comprises a thin grease made by mixing diesel oil with an alkali metal tall oil soap to which saturated NaCl brine has been added in an amount of 0.1-1 percent by volume. The addition of the NaCl brine prevents the precipitation of calcium soaps when using the fluid for drilling through anhydrite, Portland cement or other Ca or Mg containing compounds.

U.S.P. 2,430,058 Mineral Oil Rustproofing Composition. J. H. Klaber to Quaker Chemical Products Corporation.

The composition according to this patent comprises a petroleum hydrocarbon vehicle containing a corrosion inhibiting amount of a mixture of a mono-ketone having a long alkyl chain, such as hexyl phenyl ketone, and octyl alcohol. This alcohol shall be present in greater amount than the ketone. The composition is rust preventive.

PETROCHEMICALS

U.S.P. 2,428,907 Copolymers of a Diene and an Alpha-Substituted Beta-Halo Acrylonitrile. A. M. Clifford and J. G. Lichty to Wingfoot Corporation.

The copolymer according to this patent is composed of 40-80 percent of a conjugated diolefin, such as butadiene-1,3, isoprene, or chloroprene, and 60-20 percent of an alpha-alkyl-beta-halo-acrylonitrile. The compounds produced are rubber-like.

U.S.P. 2,429,133 Aviation Motor Fuel. T. B. McCulloch to Standard Oil Development Company.

The aviation motor fuel according to this patent comprises a major portion of a high-boiling isoparaffinic hydrocarbon of high anti-knock value, e.g., 75-85 percent of an isoparaffin with 6 or more C atoms, and a minor portion of methyl, ethyl, propyl, butyl, or iso-amyl benzoate, or the methyl or ethyl ester of toluic acid. These additions give unusual performance to aviation motor fuels under rich mixture conditions.

U.S.P. Re. 22,930 Tertiary Butyl Derivative of Hemimellitene and Process for Preparing Same. M. S. Carpenter to Givandan-Delawanna Inc.

A butyl xylene, formaldehyde, HCl and H_2SO_4 are reacted at 50-70° C. The reaction mixture is cooled, the acid layer is then discarded, and the oily portion of the reaction mixture is dechlorinated. The oily layer is distilled off the reac-

tion product and is redistilled. The fraction boiling at 92° C. under 3.5 mm Hg is collected and consists of a tert-butyl derivative of hemimellitine, e.g., 1,2,3,-trimethyl-5-tert-butyl benzene. It is a colorless crystalline material with the m.p. of 32-33° C.

U.S.P. 2,429,373 Manufacture of 2,2,3-Trimethylbutane. L. Schmerling to Universal Oil Products Company.

A 2,3-dimethylbutane is reacted with chloromethyl methyl ether to form a methoxy chloroheptane. This product is dehydrochlorinated to form methoxy heptene. The latter is hydrogenated and hydrogenolyzed to form 2,2,3-trimethylbutane. A Friedel-Crafts metal halide can be used in the formation of the chlorinated heptane at a temperature of 0-50° C. The hydrogenation and hydrogenolysis can be effected in the presence of a Ni-containing hydrogenation catalyst.

U.S.P. 2,429,501 Preparation of Alicyclic Aldehydes. H. L. Yale and G. W. Hearne to Shell Development Company.

A cyclic non-tertiary olefin with more than 5 nuclear C atoms, such as cyclohexene or trimethylcyclohexene, is reacted with an oxygen-containing mercuric salt, such as $HgSO_4$, at a temperature of 20-70° C. The addition complex formed is heated in a solution of an acid medium with a pH of less than 4 at a temperature (e.g., 100° C.) sufficiently high to effect decomposition of the complex and formation of an alicyclic aldehyde, such as cyclopentane carboxaldehyde.

U.S.P. 2,429,565 Reaction Products of Hexamethylenetetramine and Petroleum Wax Substituted Oxyaromatic Compounds Having Rubberlike Properties and Method of Preparing Same. O. M. Reiff to Socony-Vacuum Oil Company, Inc.

Two percent of hexamethylenetetramine are reacted with a composition formed by chlorinating petroleum wax to the extent of 27 percent by weight, reacting the product formed by a Friedel-Crafts reaction with phenol, a naphthol or a diphenyl ether in the ratio of 3 mols of chlorinated wax to 1 mol of the oxyaromatic compound and removing the residual Cl_2 from the composition before reacting it with the hexamethylenetetramine by treating the composition with dilute NaOH at 500° F. for 2-4 hours. The product obtained has rubber-like properties.

U.S.P. 2,429,582 Process for Producing Polymers of Branched Chain Hexadienes. R. C. Morris and J. L. Van Winkle to Shell Development Company.

A dimethylsulfolene, such as 2,4-dimethyl-3-sulfolene, is heated in the presence of molecular oxygen or peroxides at a temperature of 80-200° C. Low molecular weight polymers of branch-chain hexadienes are obtained.

U.S.P. 2,429,622 Catalytic Production of Ethyl Benzene. J. H. Hirsch to Foster Wheeler Corporation.

A charging stock of benzene and ethyl alcohol is passed through a dehydration zone where ethylene and water are produced. The water is removed and the products of reaction are then passed into a catalytic reaction zone wherein the

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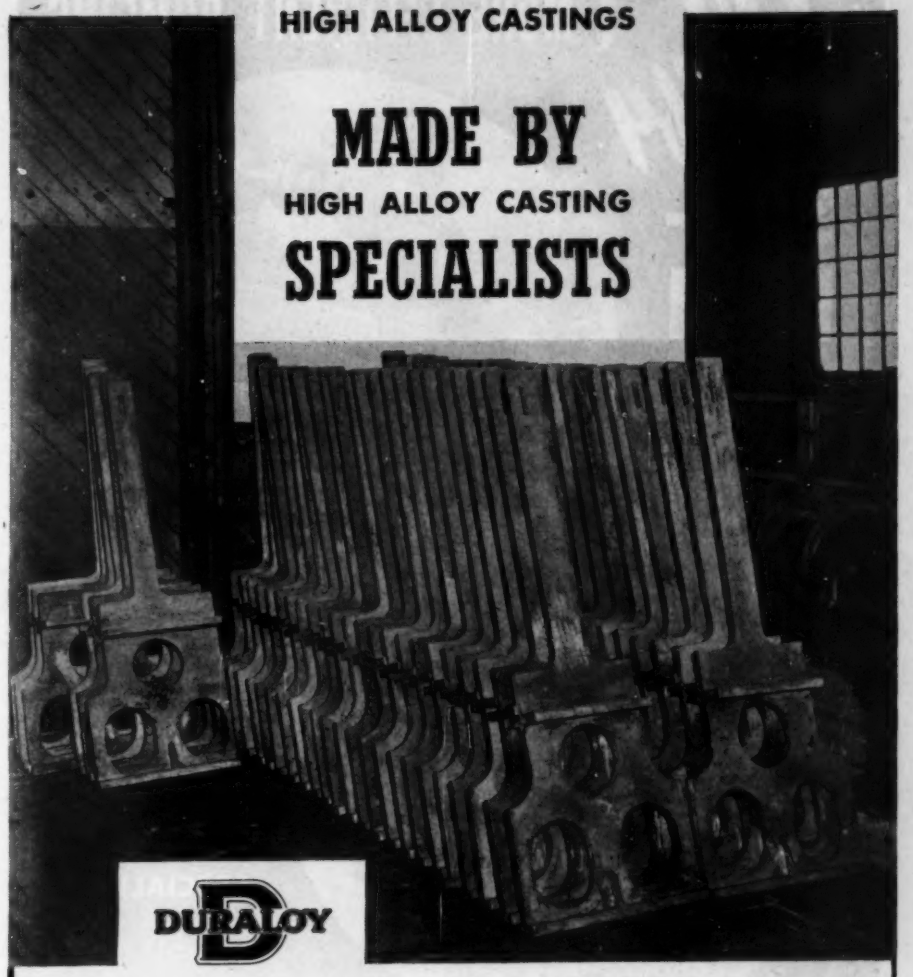

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conversion of ethylene and benzene into ethylbenzene is completed.

U.S.P. 2,429,758 Manufacture of Isopropyl Chloride. F. C. Holmes to Ethyl Corporation.

Gaseous HCl and propylene are contacted with granular anhydrous $CaSO_4$. Isopropyl chloride is obtained. A propylene-ethylene mixture can also be selectively chlorinated in the indicated manner giving isopropyl chloride. For example, an ethylene gas stream containing 3 percent propylene can be treated with HCl gas in the presence of the catalyst at a temperature of 35° C. and a pressure of 100 psi. No detectable ethyl chloride is formed but all but 0.1 percent by volume of the propylene is transformed into its chloride.

U.S.P. 2,429,963 Preparation of Polychlorinated Saturated Aliphatic Hydrocarbons. O. Reitlinger.

Gaseous saturated aliphatic hydrocarbons are mixed with chlorine in such proportions that the mol ratio between both reactants is between 1:1 and 3:1. The mixture is heated to reaction temperature, e.g., below 60° C. Another amount of chlorine is then added stepwise at speed below that of the flow of the mixture and in such amount that the mol ratio between Cl and the other components of the mixture does not substantially exceed 1:1, in order to avoid a dangerous heat generation by the chlorination reaction. Polychlorinated aliphatic hydrocarbons are obtained, e. g., CCl_4 from CH_4.

U.S.P. 2,430,137 Manufacture of Methylcyclohexenes. A. G. Oblad and E. Gorin to Socony-Vacuum Oil Company, Inc.

1-methylcyclohexene-1 and 4-methylcyclohexene-1 are produced by first catalytically dimerizing propylene, then fractionating the resulting product to obtain a fraction boiling at 60-70° C. This fraction is pyrolyzed to obtain a product stream containing equimolecular quantities of isoprene and ethylene and equimolecular quantities of 1,3-butadiene and propylene. These four constituents of the mixture are separated from one another. The isoprene is thermally condensed with ethylene to obtain 1-methylcyclohexene-1, and the 1,3-butadiene is thermally condensed with propylene to obtain 4-methylcyclohexene-1.

U.S.P. 2,430,313 Processes for Copolymerizing Monoethylenic Hydrocarbons with Compounds of the Maleic Anhydride Type. C. A. Vana to E. I. du Pont de Nemours & Company.

Maleic anhydride is copolymerized with a monoethylenic hydrocarbon, particularly with styrene, by means of a peroxide polymerization catalyst in an inert solvent of distinct properties and under particular conditions.

U.S.P. 2,430,326 Production of Dichloropropylenes. H. A. Cheney and S. H. McAllister to Shell Development Co.

Propylene is preheated and mixed with allyl chloride vapors. The mixture is blended with chlorine at a temperature of at least 120° C. Chlorination is then effected at a temperature of between 200° C. and the temperature at which substantial degradation is favored (e.g., at a temperature of 350-675° C.) Dichlor-

opropylenes having the Cl atoms in the allyl and vinyl positions, i. e., such predominating in cis and trans 1,3-dichloropropylenes are obtained. The allyl chloride-to-propylene mole ratio can, for example, be between 0.5:1 and 3.0:1 and the unsaturates-to-chlorine mole ratio between 2:1 and 7:1.

DESULFURIZATION

U.S.P. 2,430,269 Mercaptan Extraction. R. T. Bell to The Pure Oil Company. Mixtures of liquid hydrocarbons, chiefly consisting of normally liquid olefins, with at least 25 percent by weight of liquid mercaptans are contacted with a solution consisting of alkali metal hydroxide, methanol and water and containing 10-30 percent of water and a sufficient amount of the hydroxide to react with all the mercaptans present but less than twice the stoichiometric equivalent of the latter. The mixture can be extracted in a plurality of steps, the water content of the added solution decreasing in each successive step. The charge material to be treated is obtained in the preparation of mercaptans by reacting olefins with H_2S in the presence of catalysts.

New Standard Hydrocarbon Samples Listed by NBS

Through a cooperative program of the National Bureau of Standards and the American Petroleum Institute, 126 compounds are now available as NBS standard samples of hydrocarbons for calibrating analytical instruments and apparatus in research, development, and analytical laobratories. The program was initiated in 1943 at the request of the Petroleum Industry War Council to meet industry urgent need for standards of high purity for calibration of spectrometers. The most recent additions to the series of compounds, each priced at $35 per unit, have been announced by the Bureau as follows:

NBS Sample No.[a]	Compound	Amount of Impurity[b] Mole Percent	Volume per Unit[c] ml (Liquid)
523-5S	1,2-Diethylbenzene.....	0.05±0.03	5
525-5S	1,4-Diethylbenzene.....	0.07±0.02	5
531-5S	3-Methyl-1-pentene.....	0.30±0.20	5
533-5S	2-Methyl-2-pentene.....	0.09±0.05	5
534-5S	cis-3-Methyl-2-pentene....	0.15±0.08	5
545-5S	2,4,4-Trimethyl-1-pentene.	0.09±0.03	5
546-5S	2,4,4-Trimethyl-2-pentene.	0.08±0.05	5

[a] The designation "—5S" following the sample number indicates a sample of 5 ml sealed "in vacuum" in a special Pyrex glass ampoule with internal "break-off" tip.

[b] The purity has been evaluated from measurements of freezing points, as described in J. Research Natl. Bur. Standards **35,** 355 (1945) RP1676; unless otherwise indicated.

[c] Tolerance approximately ± 10 percent.

Instructions for transferring standard samples of hydrocarbons "in vacuum" are available on request. A complete list of NBS standard samples of hydrocarbons, together with instructions for ordering, may be also obtained from the National Bureau of Standards, Washington 25, D. C.

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ASTM's 1947 Volume On Petroleum and Products

The American Society for Testing Materials announce the availability of the 1947 volume of ASTM Standards on Petroleum Products and Lubricants (with related information). In it are the more than 130 test methods, specifications, definitions, issued by ASTM and covering a range of petroleum products. The book also includes nine proposed methods, these to elicit comment.

The book contains tests and specifications for motor and aviation fuels, diesel and burner fuels, kerosine and illuminating oils, lubricating oils and grease, and petrolatums and waxes. Also covered are plant spray oils, petroleum sulfonates, electrical insulating oils and an extensive series of specifications and tests on hydrocarbon solvents. Tests pertaining to crude petroleum and requirements on thermometers are given as are all requirements on petroleum excepting those for engine test methods on fuels (slated for February publication).

Copies can be procured from ATSM headquarters, 1916 Race Street, Philadelphia 3, Pa., at $4.75 in paper cover and $5.40 in cloth binding.

German Patent Translation

Hobart Publishing Company, Chevy Chase Drive, Washington, D. C. has announced a complete translation of the German technical report "Polymerization of Acetylene to Cyclooctateraene."

The report is available from the Office of Technical Services, United States Department of Commerce but the portion dealing with the German patents and patent applications, some 40 pages, heretofore had not been translated.

The translated material includes: Process for preparation of cyclic polyolefins, process for the preparation of cycloparaffins, process for the preparation of phenylacetaldehyde or beta-phenyl-alpha, alpha-ethylidenediesters, process for the dimerization of cyclooctateraene, preparation of addition compounds of cyclooctatetraene, process for the preparation of cyclooctene, preparation of a hydrocarbon, high molecular weight unsaturated hydrocarbons, halides of cyclooctatetraene, preparation of saturated hydrocarbons, process for the dimerization of cyclooctatetraene, preparation of condensation products, preparation of unsaturated halogen containing hydrocarbons, preparation of isocyclic compounds, process for the preparation of esters, preparation of suberic acid and preparation of suberane aldehyde.

The price of the completely translated report, done by Dr. Karl Kammermeyer, with numerous corrections having made to the English portion, is $17.50. This is a limited edition of several hundred copies.

Industrial Waste Disposal

"Industrial Waste Disposal" for petroleum refineries and allied plants, by W. B. Hart, has been published in book form by Petroleum Processing, 1213 West Third Street, Cleveland 13, Ohio, and is available at $4 per copy.

Included are a brief review of economic and legislative backgrounds, discussion of the kinds of industrial wastes and their harmful effects and detailed explanation of proper waste disposal methods and equipment.

New EQUIPMENT MANUFACTURERS' LITERATURE

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1—Steam Hose

A new glass cord steam hose, a product of Goodyear Tire & Rubber Co., represents the result of joint researches carried on by that company and Owens-Corning Fiberglas Corp. of Toledo, Ohio.

In developing this glass cord steam hose, Goodyear and Corning scientists solved a problem that has long troubled industries that require a hose that can be used to conduct saturated steam under high pressure. Such a hose must be strong enough to withstand the steam pressure since a sudden blowout would be extremely dangerous to the men using it. In addition to strength, it must also possess flexibility and it must not possess undue bulk. Moreover, the constant flexing to which the hose is subjected must not lead to mechanical breakdowns with subsequent blowouts.

As is well known, the familiar method of building a hose is to put some sort of fabric layer between an outer and inner tube of rubber. In developing this hose cotton fabrics could not be used because they begin to "bake" and char at temperatures over 250° F., and quickly lose their strength. A wire fabric would possess the necessary strength but not the desired flexibility, and flexing leads, in time, to breakdowns of the wire mesh. Steam hose has been made with asbestos fabric and yarn, but they are bulky. Asbestos cords are about 3/32 of an inch in diameter and the result is a wall about 5/8 of an inch thick.

The fiberglas cords, twisted yarn made of glass fibers and then coated with rubber, are only 25/1000 of an inch in diameter and result in a wall only 9/32 of an inch in thickness. Coating the fiberglas yarn with rubber is an important step in the process, because it prevents the development of friction between individual cords in the finished product.

Among the important uses for steam hose is in fire fighting at oil refineries.

It is stated that the new hose will carry saturated steam at a temperature of 388 degrees Fahrenheit at a pressure of 200 pounds, and in tests the hose has stood up under 300 hours of continuous flexing at 200 pounds working pressure.

2—Gate Valves

Incorporating the first application of full cylindrical body sections to bronze gate valves, the new Lunkenheimer 2228 provides maximum distortion resistance. Tests, setting up pipe line stresses and internal pressures far in excess of actual service conditions, have shown no distortion in body or valve seats, the manufacturers claim.

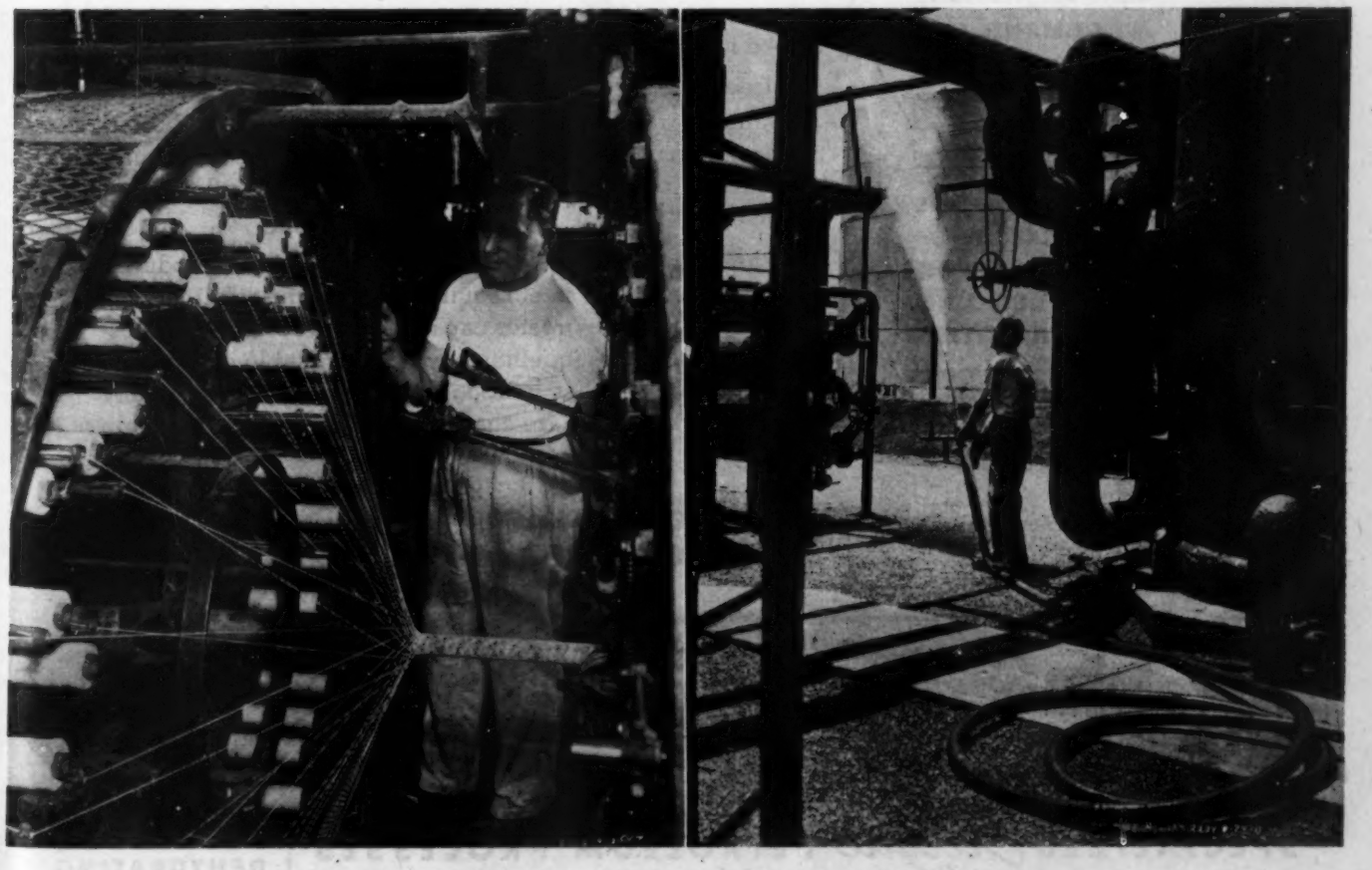
Among the features are a patented silicon alloy stem material which eliminates stem-thread failures; hexagon head gland; beveled disc wing guides and body guide channels to make assembly easy when servicing the valve.

Circular No. 534 is available from The Lunkenheimer Company, Cincinnati 14.

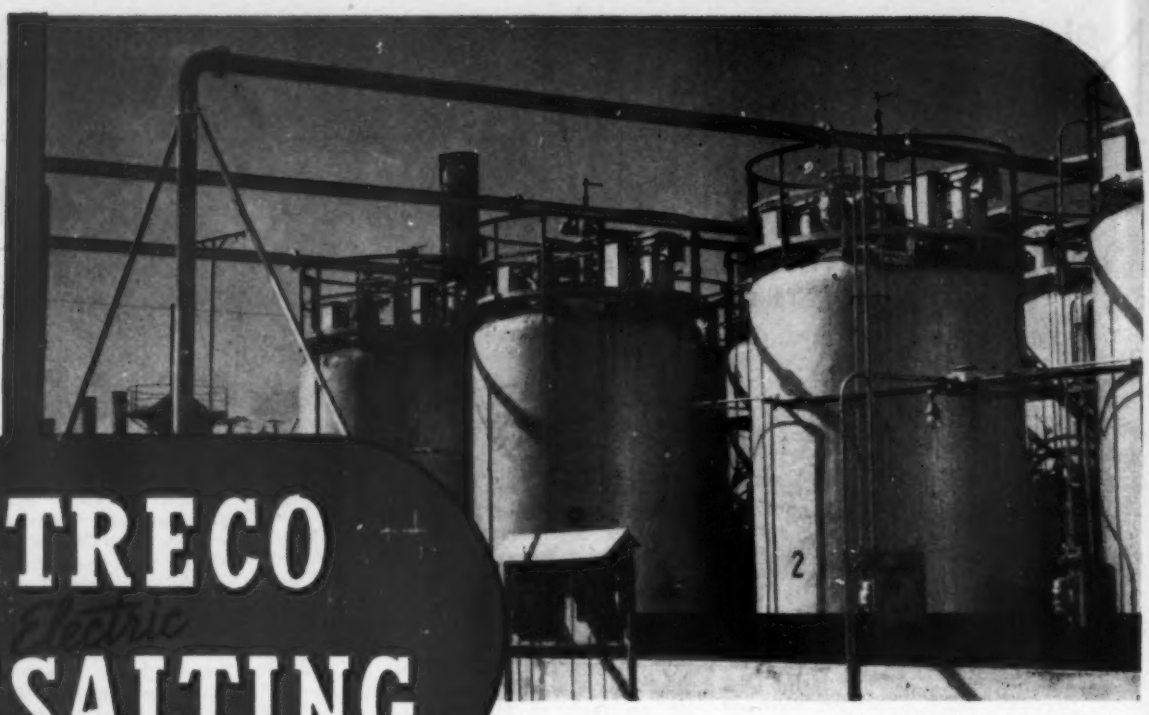
3—Electrode Toolweld

The Lincoln Electric Company, Cleveland 1, has announced a new electrode, Toolweld A & O, for hard surfacing tools and dies.

Toolweld A & O ("A" for air-quench; "O" for oil-quench) is for use in building up the working surfaces or edges of cold-working metal cutting and forming tools. It will produce surfaces of high



Left, weaving fiberglas cords around hose and, right, hose in use at industrial plant.



PETRECO *Electric* DESALTING

Photo by Permission of Sunray Oil Corp.

IS VITAL TO REFINING EFFICIENCY NOW...

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BECAUSE OF THE SCARCITY OF **STEEL FOR NEW REFINING FACILITIES**

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Petreco Electric Desalting prevents salt plugging and hard coking. It retards corrosion caused by evolved HCl. It eliminates many impurities which are major causes of equipment depreciation, metal losses and high replacement demands.

In the face of increasing demands for petroleum products, and the scarcity of steel required to build the refining units needed to provide greater capacities, it is absolutely necessary to get maximum efficiency from available equipment. This is exactly what Petreco Desalting is enabling many refiners to do; if you are charging salty crudes, we can help you, too.

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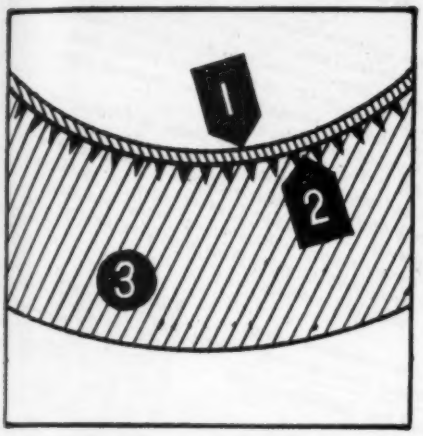
PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR 48-1

strength for resisting wear and impact in all applications where high temperatures are not encountered. When deposited on either ordinary carbon steel or on any one of the hundreds of alloy steels, Toolweld A & O produces a surface whose properties will match those of the best tool and die steels. The deposited weld metal is of the 5 percent chrome type and may either be used as welded or subjected to a wide range of heat treatments.

The electrode will operate on either ac or dc current, electrode negative with dc.



Cross section of N-B-M gridded bearing, showing 1) .002" lead-tin alloy "run-in" surface; 2) Precision-spaced grids filled with N-B-M silver babbitt; 3) Centrifugally-cast lead-bronze shell.

4—Precision-Built Bearings

National Bearing Division of American Brake Shoe Company, St. Louis 10, has announced discovery of a simple method of building precision gridded bearings at mass-production savings. Gridded bearings utilize a principle of cutting tiny grids into a bearing shell and filling them with babbitt, and are claimed to provide longer life and lower maintenance costs for many types of high speed, heavy duty engines and machinery.

Gridding centrifugally cast lead-tin bronze, to combine its advantages with those of babbitt is claimed by National Bearing engineers to result in an almost ideal combination of good bearing properties: the gridded area provides conformability in a strong bronze bearing, plus embedability equal to that of the babbitts. It also overcomes objections to using bronze with a shaft that is hardened, because the gridded bearing is "self-healing." In periods of great overstress, some of the babbitt melts out of the grids and forms a running surface that prevents seizure. Where an ordinary bearing would seize and fail, the babbitted grids provide a safety factor that prevents damage to the shaft.

N-B-M gridded bearings are customarily made as half bushings, but can be furnished as full cylindrical bearings if desired. Complete engineering data are available.

5—Pneumatic Transmitter

A new transmitter, identified as Model 42, is announced by The Foxboro Company, Foxboro, Mass., for use in the pneumatic transmission of industrial process measurements such as flow, static or differential pressure, liquid

AIRETOOL CONDENSER AND HEAT EXCHANGER TUBE CLEANERS

AIRETOOL NO. CC-375 GEARED CLEANER

The air or steam driven motor has a maximum of 1200 RPM . . . powerful enough to cut through the heaviest scale. Light-weight, sturdy, aluminum-alloy case. Handle valve gives positive control. For condenser and heat exchanger tubes from ⅜" to 1¾" I.D. . . . all scale conditions.

AIRETOOL NO. CC-325 GEARED CLEANER

Airetool's most powerful cleaner for condenser and heat exchanger tubes. Particularly effective where scale conditions require low speed and extreme power. Air or steam driven motor operates up to a maximum of 800 RPM. Light-weight, sturdy, aluminum-alloy case. Positive control handle valve. For tubes from ⅜" to 2½" I.D.

AIRETOOL NO. CC-450 DIRECT DRIVE CLEANER

Extremely light, weighing only 21 lbs. Can be used with or without supporting rig. Direct drive motor is air or steam driven and employs Airetool's slip-fit construction which permits maintenance without special tools. Sturdy, light, aluminum-alloy case . . . positive control handle valve. Thoroughly cleans all scale conditions in heat exchanger and condenser tubes from ⅜" to 1½" I.D.

. . . for descriptive bulletin write

AIRETOOL MANUFACTURING COMPANY
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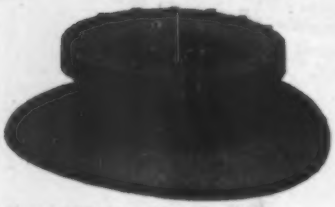
SPRINGFIELD, OHIO

THERE'S AN AIRETOOL TUBE CLEANER AND EXPANDER FOR EVERY TYPE OF TUBULAR CONSTRUCTION

LENAPE LOW COST TYPE R MANWAYS

LENAPE MANWAYS ARE PRODUCED IN STEEL, AND A VARIETY OF STAINLESS COMPOSITIONS

Type "R" Manway



Type "R" Nozzle with Cover

Lenape *Type R Manways* offer decided cost reductions in comparison with American Standard Manways of similar rating. Produced to meet ASME Code requirements, these seamless manways are available in heavy type (200 psi) and light type (125 psi) with 16", 18", 20", and 24" openings as standard. Both heavy and light types can be supplied "long" (12" height) or "short" (5" to 8" height) depending upon opening diameter. Slightly curved radius makes for easy entry. Dished covers are available. Swing covers, davits, and similar special details can be supplied for Manway service.

Lenape Type R Nozzles are supplied of heavy or light as above, in short model only. These nozzles are curved to cylindrical diameter or spherical radius as specified.

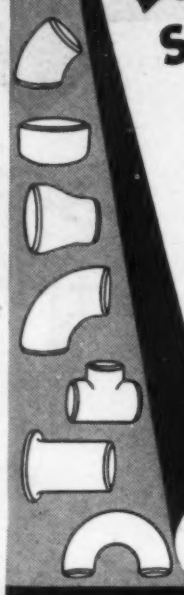
Quotations will be given our immediate attention — Bulletin 4-61 and current price schedule M-47 will be sent upon request.

LENAPE HYDRAULIC PRESSING AND FORGING CO.

LENAPE HYDRAULIC PRESSING & FORGING CO.
P.O. BOX 106 WEST CHESTER, PA.
RED MAN PRODUCTS

2824 STAINLESS STOCK ITEMS

in P. P. & E. Stainless Steel Welding Fittings . . .



The most complete line ever offered—available in three Stainless Types (304, 316, 347) to match pipe and tubing of various wall thicknesses in sizes from ¾" through 12"; in all standard fittings illustrated. Special fittings, and other analyses, can be supplied on special order.

All P. P. & E. fittings are made of forged or rolled stock; annealed, blasted, and passivated for maximum corrosion resistance. Their use makes possible fabrication of every type of stainless piping system with minimum equipment simply by straight cutting of tubes to desired lengths, and plain butt welding.

The most complete line of Stainless Steel Welding Fittings

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PITTSBURGH PIPING and EQUIPMENT COMPANY
10 43rd Street · Pittsburgh, Penna.
World's Largest Manufacturer of Stainless Steel Welding Fittings

Hi-Pressure Gage Glasses

Round, Tubular and Flat Type

Fig. 12

RUBBER GAGE GLASS GASKETS
Series 750 . . . All Sizes

Fig. 21 Fig. 22

Other Ernst Specialties
(Complete Catalog No. 48 P)

GAGE GLASS ILLUMINATORS
NEW PLASTIC GUARDS
SIGHT FLOW INDICATORS
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ALL IRON GAGES
HIGH & LOW ALARM COLUMNS
MICA SHIELDS AND GASKETS
AND OTHER HELPFUL TIPS ON BOILER ROOM SAFETY

Send for Catalog 48P

Inclined for Better Visibility
Standard Type—Offset Adjustable Inclined Gage Fittings
Fig. 47

Fig. 13
Leakless Super Try Cocks, Bronze and Forged Steel Construction

Ernst WATER COLUMN & GAGE CO.
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The Flow of Homogeneous Fluids Through Porous Media

by M. MUSKAT
Chief of Physics Division, Gulf Research & Development Co.

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ANALYTIC METHODS FOR SOLVING FLOW PROBLEMS

A complete treatment of the flow of homogeneous fluids through porous media, covering all typical problems of practical interest and laying particular stress upon the illustration of the various analytical methods available for solving flow problems. A needed and specialized reference work for engineers in the oil and gas industries, also widely applicable to the study of hydrological questions, irrigation, dam-construction problems, and those involving fluid flow through refractories and ceramic materials.

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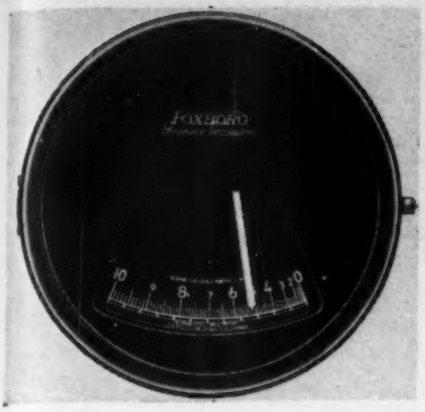
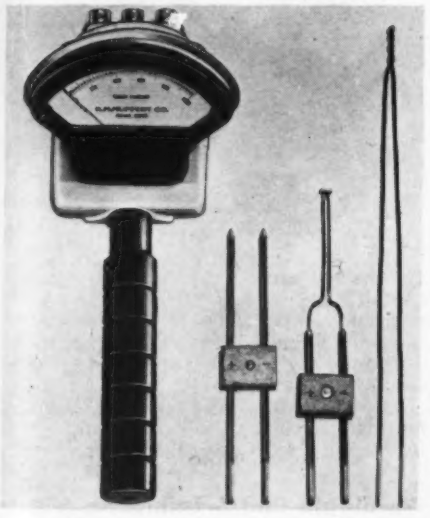


level, temperature or humidity. It is available with either an eccentric or concentric scale.

An improved design of the previous Foxboro transmitter, the changes include a completely new transmitting element, which is exactly duplicated in the receiving instrument. This results in improved accuracy in transmission. Simplified calibration is another advantage gained. Ask for Bulletin 409.

6—Pyrometer Accessories

The extended field of applications for its line of portable pyrometers, the instrument division of the K. H. Huppert Company, 6830 Cottage Grove Avenue, Chicago 37, includes a recently com-

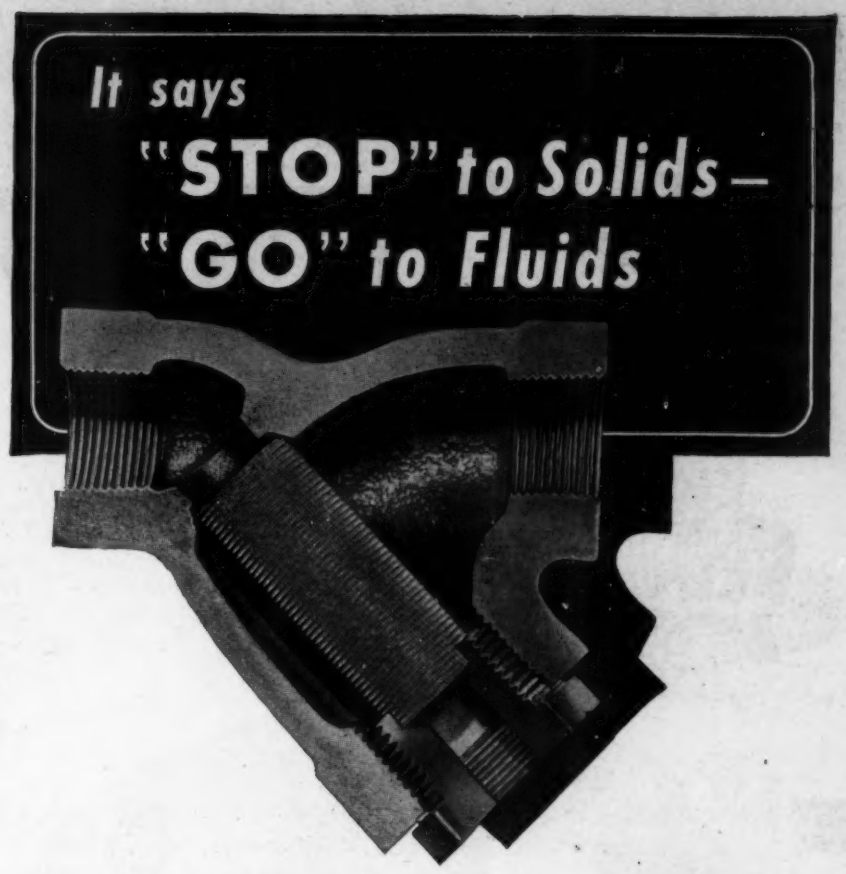


pleted series of pyrometer thermocouples—a closed-end type with a silver tip suitable for highly accurate temperature readings on hot metal, rubber or plastic surfaces.

The instrument weighs 1¾ pounds, has a cast aluminum body, with the scale set at an easily read angle which prevents distortion and side reflections. Standard duo-range scales in either Fahrenheit or Centigrade are carried, with special scales made to order.

7—Wet Film Apparatus

An apparatus has been developed by Henry A. Gardner Laboratory, Inc., 4723 Elm Street, Bethesda, Maryland, that affords the technical worker a multiple tool for laying down film-forming media of any predetermined film thickness. Known as the Boston-Bradley adjustable blade, the apparatus



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6 sizes from ½" to 2" for pressures up to 600 lb. Reasonably priced. See your supply house or write for Bulletin S-201.

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Style V3-84C

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Style X41

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Style No. 701

DOUBLE BARRELED PROTECTION . . . Two replaceable chemical cartridge filters highly effective against low concentrations of vapors; provide low breathing resistance. *Reg. U. S. Pat. Off.

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DOUBLE WILLSON PRODUCTS INCORPORATED

READING, PA., U.S.A. Established 1870

130 THORN ST., READING, PA., U. S. A.

is made in three widths, 3, 6, and the special, for desired widths up to 12 inches.

The firm also announces production of an interchemical direct reading wet film thickness gauge for measuring the wet film thickness of paint, varnish, lacquers, and related products. The instrument has an accuracy of 0.1 mil.

8—Tire Inflator, Fire Extinguisher

Power-Pak tire inflator-fire extinguisher units, available in a heavy duty model, have been announced by Power-Pak Products, Inc., Buffalo 2, N. Y.

Big brother to the smaller 10-ounce

automotive unit, the heavy duty model contains 2½ pounds of CO_2, a much increased capacity. It weighs 8½ pounds, is easily mounted by means of a metal wall bracket provided and a metal grip facilitates handling.

The cylinder, measuring 17 inches long and 3½ inches in diameter, conforms with I.C.C. specifications.

9—Single-Phase Induction Motor

A new single-phase squirrel-cage motor of wholly new design is announced by Westinghouse Electric Corporation, 306 Fourth Avenue, Pittsburgh 30. The new capacitor-start, single-phase motor is sturdy, its windings are rugged, and the bearings are pre-lubricated requiring no attention for at least five years.

A centrifugal switch of improved design, manufactured under close tolerances, is used on motors rated one to three hp inclusive at 1750 rpm and 1½ to five hp at 3600 rpm.

The capacitor is mounted in the conduit box, a location easily accessible and providing a lower ambient temperature. The repulsion-start motor has higher break-away torque, but the new single-phase can bring up to full speeds loads that will cause the repulsion motor to start. The new motor has high torque valves all the way up from standstill to full speed. Thus compressors can be

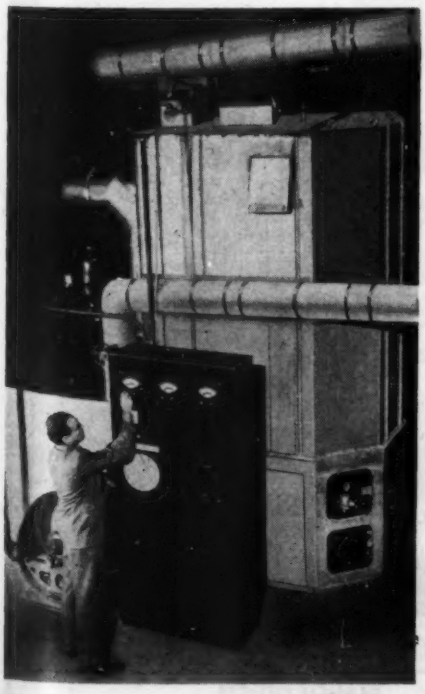
GE's Single-Phase Induction Motor

driven by the simplest form of induction motor—the die-cast, squirrel-cage machine. It avoids the wound armature, brushes, brush-holders, short-circuiting devices with the possibility of high-resistance contacts and the variation in speed calibration. The capacitor-start motor is electrically reversible and its characteristics fixed, not subject to change by brush shift.

10—Heat-Medium Salt and Boiler

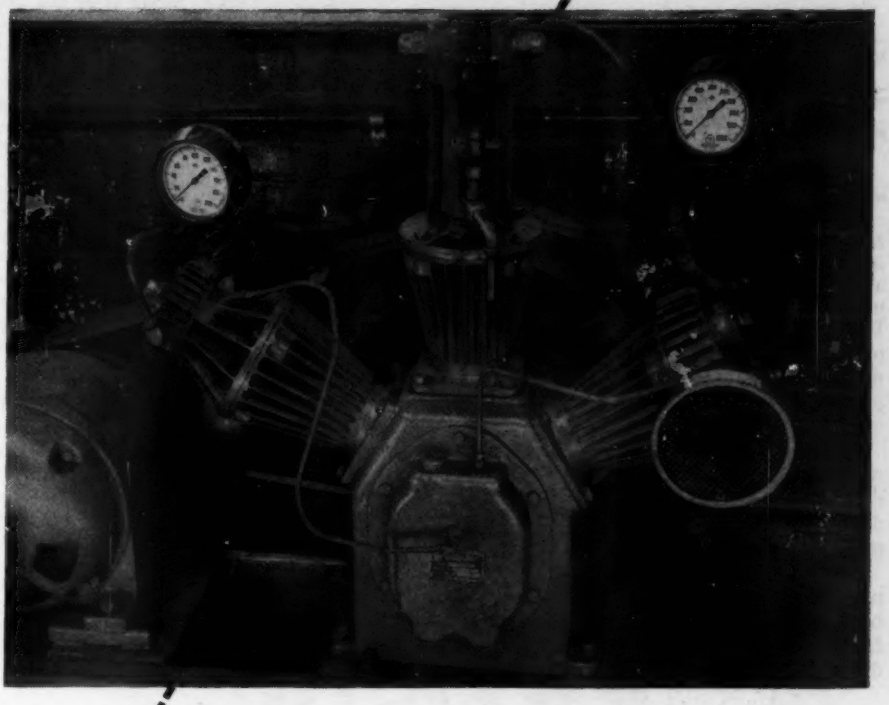
Introduction of a new heat-medium salt and a specially designed boiler for its utilization is claimed to bridge the gap existing in the precision control of process heat supply in the temperature range between steam and direct firing, and to eliminate high working pressures and expensive equipment. The new boiler, termed a "Beth-Tec" Unit, is a complete assembly of tubes, headers, and manifolds, with integral furnace combustion chamber. It is said to be completely automatic in operation, with all instruments of the "fail-safe" type, and is manufactured by Bethlehem Foundry & Machine Company of Bethlehem, Pa.

The heat medium used in this new boiler is "Hi-Tec" heat transfer salt, a



Beth-Tec Unit in Operation

Here's how HELICOID GAGES

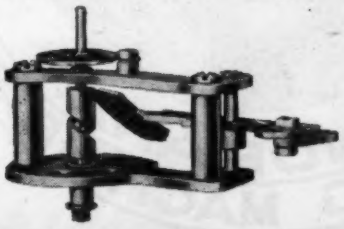


PAY OFF!

On a compressor like this, where you have vibration and rapid pressure pulsations, ordinary gages with clock gear movements last but a short time. Sometimes the gears are worn out in a few weeks.

By comparison, Helicoid gages wear for years. Actually, the gages shown here have been in service for 2½ years and are still going strong.

This is an example of the saving in maintenance which can be made by using Helicoid—the gage of enduring accuracy.



Only Helicoid gages have Helicoid movement

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

high temperature heat transfer liquid formulated by E. I. duPont de Nemours and Company. The service range of this salt is compared with other heat transfer mediums in the following table:

FLUID	Usual Temperature Limits	Pressures (psig)
Steam or Water.....	32°—460° F.	0—450
Oil.....	30°—550° F.	0
Organic Compound (Mixture of Diphenyoxide and Diphenyl)	54°—700° F.	0—135
Mercury.....	—37°—1000° F. or higher	0—180 or higher
"Hi-Tec".....	290°—1000° F.	0
Flue Gas or Air.....	Up to 800° F. in iron ducts, to 1600° F. in special alloy	0

As an accessory to the boiler, a sump tank is included on the bottom of which is located either a steam heating coil or an electric immersion heater which melts the salt for the initial operations. In addition, there is a submerged salt pump for initiating and continuing the flow of the salt. Inspection manholes are provided to enable easy checking during operations.

Atop the boiler are the two salt control valves which are the air-operated diaphragm type. These have specially designed stuffing boxes and are completely jacketed for steam heating.

At the bottom of the furnace is a proportioning type of oil burner and blower designed to supply air for combustion. These are equipped with safety devices including a "flame-eye" and "flame - electrodes." Duplex fuel oil pumps are provided.

Separate from the unit itself is the instrument and control panel. This is complete with all necessary instrumentation and safety controls to provide "fail-safe" operation under all conditions.

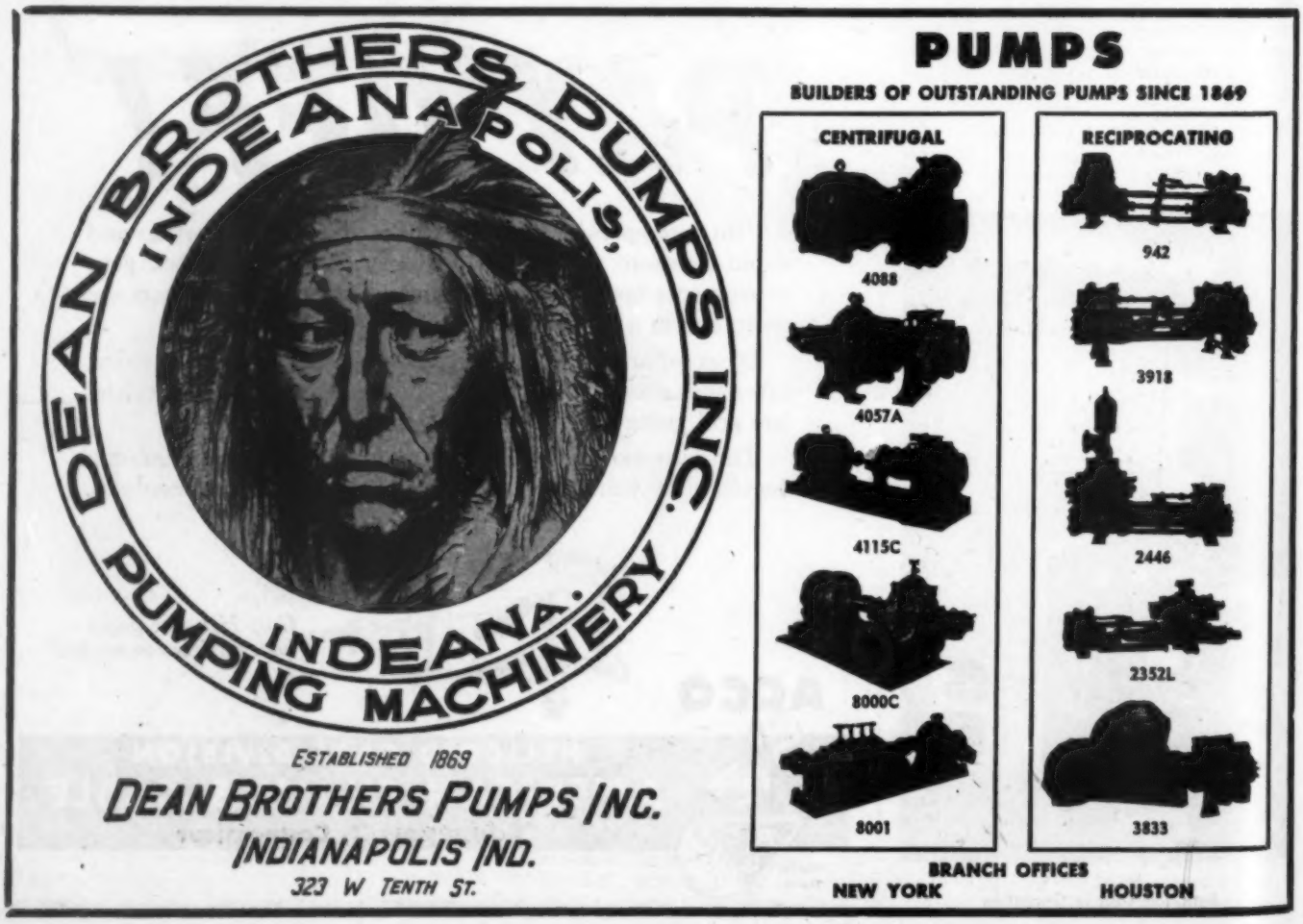
Units are available from 500,000 to 2,500,000 Btu per hour in continuous operation at 650° F. operating at an approximate over-all efficiency of 50 percent.

Physical Test Specimen Employing Flagg-Flow Threadless Malleable Fittings. The tensile specimen pulled at 32,000 pounds which is 65,000 psi.

11—Threadless Malleable Fittings

Malleable pipe fittings, the first threadless malleable fittings made for brazed pipe joints, have been announced by Stanley G. Flagg & Company, Inc., of Philadelphia. The threadless fitting is a black malleable socket type intended for brazing to steel or wrought iron pipe. It is claimed that the fitting simplifies piping layout and makes it possible to join steel or wrought iron pipe without threads and without welding by a brazing method any competent pipe fitter can use, that "the new fitting brings to industry the benefits of ordi-

Flagg-Flow Malleable Pipe Tee Fitting



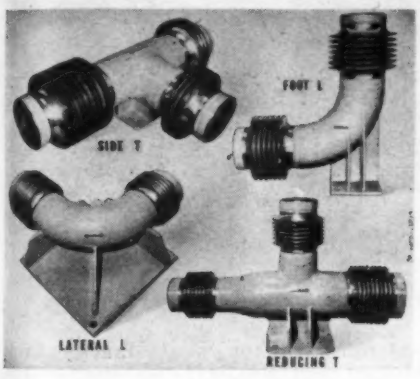
narily high-priced welded or brazed installations at a cost no higher than ordinary screwed pipe installations, and will undoubtedly put steel pipe in competition with copper and brass."

The fitting enables the use of plain end pipe, eliminating thread cuttting which otherwise would weaken the pipe wall by reducing its thickness. Flagg-Flow also is said to afford 30 percent less weight than the same kind and size of threaded fitting, because of the absence of the chamber, and makes possible the use of lighter weight pipe throughout the system.

Designed for brazing to standard black steel or wrought iron pipe, the new fittings are currently made in sizes up to and including two inches, which comprise a large portion of the piping now installed.

12—Expansion Fitting Line

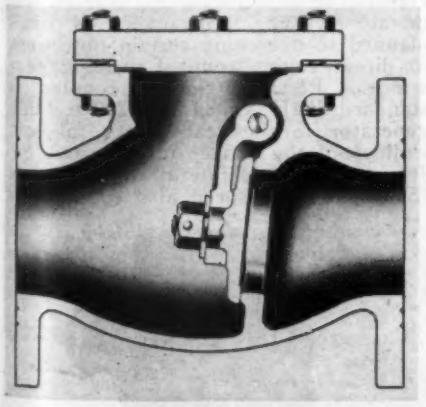
Addition of a new line of anchor base expansion joint pipe fittings to their six standard series of packless expansion joints is announced by Magnilastic, a division of Cook Electric Company, Chi-



cago 14. Four typical units are illustrated: a side "T", foot "L", lateral "L", and reducing "T", all of stainless steel. Note in the side "T" how number of bellows flanges may be varied to accommodate unequal expansion in each leg. Each of these particular fittings stem from the standard MagniLastic 400-pound series and were constructed for steam lines.

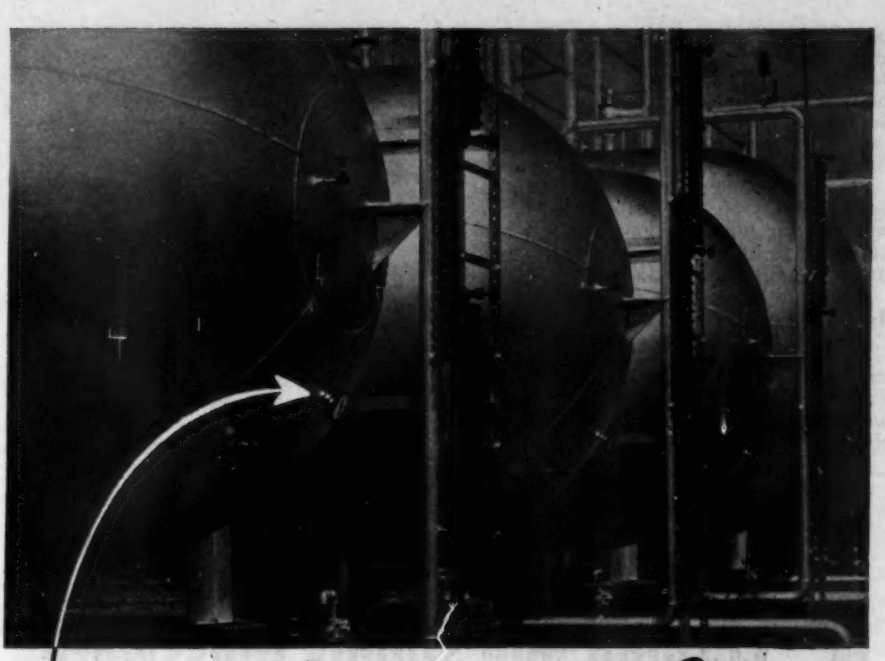
13—Swing Check Valves

Crane Company, 836 S. Michigan Avenue, Chicago, has introduced new lines of corrosion-resistant swing-check valves in sizes ½-inch to 6 inches. These



valves, made in both 18-8 Mo alloy steel and monel metal, are available in sizes ½ to 2 inches with screwed or flanged ends, and in sizes 2½, 3, 4, and 6 inches with flanged ends only.

In the sizes ½ to 2-inch, the body is



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MODEL 122-D
heavy duty—straight form

MODEL 222-D
heavy duty—angle form

made in a Y-pattern, and the cap is on the same center line as the seat opening. In the 2½, 3, 4, and 6-inch sizes, the body is the straightway type, with the seat face at only a slight angle from vertical. These new checks are designed for the moderate pressures and temperatures usually encountered in piping corrosive fluids. The valves are recommended for liquid or gas working pressures up to 150 pounds and for a maximum temperature of 350° F.

14—Three-Way Butterfly Valve

A simple butterfly valve has been developed by W. S. Rockwell Company, Fairfield, Conn. for three-way operation which costs considerably less than specially engineered valves of such type.

Three-Way Butterfly Valve

This valve consists of two butterfly valves and a tee, with the valves interlocked so that the closing of one vane opens the other in any proportion. This three-way valve is ideally suited for quick interchange or diversion of flow or mixing of gases or fluids. The valve is available from 4" to 60", American standard pipe flange sizes, in cast iron or special alloys. They can be built for pressures to 100 psi and temperatures to 1800° F.

15—Safety Goggle

A new lightweight, comfortable safety goggle (AO 607) featuring an all-plastic frame with a single plastic acetate lens which provides maximum vision is announced by American Optical Company, Southbridge, Mass. This goggle is

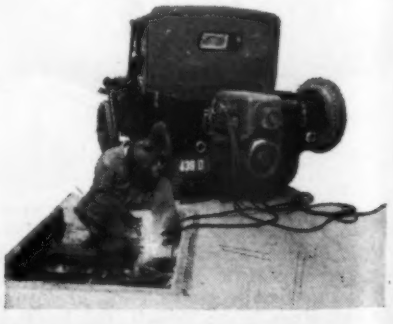
recommended for wear directly over eyes or over spectacles for frontal protection against flying particles on jobs such as machine work, hand tool operations, chemical and physical laboratory work, spot welding and light grinding, chipping and riveting.

The brown plastic frame is designed to provide unobstructed side vision, excellent frontal protection and smart appearance. No metal touches the skin.

The single plastic acetate lens is green or white, conforms to high safety standards, is easily replaceable.

16—Jeep-Mounted Welder

A new method of jeep-mounting an arc welding generator designed by the Harnischfeger Corporation, 4400 W. National Avenue, Milwaukee 14, was planned to overcome certain objections to direct engine coupled welding generators. P&H engineers coupled a standard P&H Model WG-200 welding generator to the rear power take-off. Pulleys of the proper ratio permit the Jeep engine to operate at approximately 1500 rpm. This speed also enables the



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A LINE THAT ANSWERS ALL REQUIREMENTS

GAUGE GLASSES: PYREX and CORNING brand tubular gauge glasses and MACBETH brand flat gauge glasses provide good visibility over prolonged periods, even under severe conditions (pressures up to 2,000 p.s.i.).

SIGHT GLASSES. PYREX brand sight glasses are made especially for ovens, absorption columns, reaction kettles, furnaces, pressure vessels, stills, tanks (pressures up to 300 p.s.i.) where safe internal visibility is necessary.

OIL CUP AND LUBRICATOR GLASSES: PYREX and CORNING brand glassware give you visibility plus long life on all types of machine operations.

Corning products are available from your nearest Mill Supplier . . . Call him today. Stock up. Be prepared for any emergency!

CORNING means research in GLASS

T. M. REG. PYREX U.S. PAT. OFF.

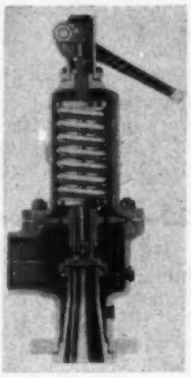
CORNING GLASS WORKS, CORNING, N.Y.
SALES OFFICES: NEW YORK, CHICAGO, SAN FRANCISCO
PYREX GAUGE GLASSES
BRAND

welding generator to operate at peak efficiency over its welding range, from minimum to maximum. V-belts are used in the hookup.

The P&H welding generator mounted for easy removal, provides a welding service range of from 30 to 260 amperes and has just one heat control for all classes of work and all types of electrodes.

Positive identification of new equipment items by name and number listed in Petroleum Refiner insure prompt replies to your requests for literature and information.

17—Safety Relief Valve



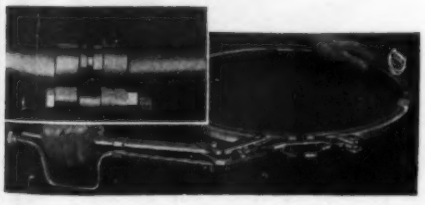
Designed for inlet pressures up to 2000 pounds and temperatures to 900° F. and for handling corrosive liquids, vapors or gas is a new safety-relief valve. Designated as Type 2680, the valve is made of cast steel with stainless steel trim. A high disc lift permits full capacity discharge. Nozzle body is of long neck construction to permit proper nozzle flow without restriction. The body is fully ribbed to absorb piping stresses.

The combination of nozzle and inverted cone or secondary nozzle makes full use of the kinetic energy of the discharge to effect the high lift and full capacity without need of adjustments.

Farris Engineering Corporation, 480 Commercial Avenue, Palisades Park, N. J., are the manufacturers.

18—Ring and Closing Tool

"Drum Parts System," made by Drum Parts, Inc., 10311 Meech Ave., Cleveland, Ohio, provides a quick method of closing bolted type sealing rings, the method embracing an improvement in the ring itself and two improvements in the closing tool. The nut used in holding the ring in position is made an integral part of the lug which is welded to the ring. This places the nut in position for faster use.



The closing tool has a self-contained wrench which is ready for use when the bolt is inserted in the lugs on the ring; also, a turnbuckle which permits quicker adjustment of the tool for variations in the size of drums.

19—Manual Heliweld Holder

A new, water-cooled manual Heliweld holder, announced by Air Reduction Sales Company, 60 East 42nd, New York 17, is designed for continuous production work with the inert-gas-shilded arc welding method features water cooling. Other features are an all-plastic exterior insulated for maximum protection and efficient operation; a gas cap made of non-conducting material and a light, flexible cable encased in a durable, translucent plastic cover. The holder has a current capacity of 300 amperes ac or dc and is fully insulated for high-frequency current.

According to the manufacturer, cooling of the holder is highly efficient and extends almost to the point at which the electrode is gripped. The new manual holder is approximately 10 inches long, weighs about 28 ounces and handles tungsten or carbon electrodes up to 3/16-inch diameters.

20—Fluorescence Analysis Unit

A new NORELCO Geiger-counter fluorescence analysis unit which utilizes a new X-ray diffraction technique, has been announced by North American Philips Company, Inc., 100 East 42nd Street, New York. The new unit determines quantitatively the purity of metals or the percentages of alloying components, and quantities of metallic elements dispersed in non-metallic carriers.

Essentially, the unit consists of an

Builders of Efficient

WELL WATER SYSTEMS

FOR CRACKING PLANTS PUMPING STATIONS AND DRILLING

When Layne builds a Well Water System for you, there need be no worry about quality, efficiency or low operation cost. Every Layne Well Water System includes just one kind of quality and that kind is the very best possible to create. As a rule, size for size, Layne Well Water Systems will produce twice as much water as other systems. The reasons are many, but primarily, it is in the "know how" gained over years of world wide experience. For further facts, catalogs, etc., address

LAYNE & BOWLER, INC.

General Offices: **MEMPHIS 8, TENN.**

LAYNE *Well Water Systems*

VERTICAL TURBINE Pumps

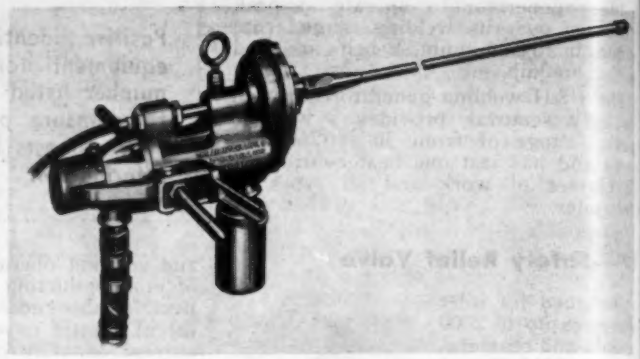
AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. * Layne Atlantic Co., Norfolk, Va. * Layne-Central Co., Memphis, Tenn. * Layne-Northern Co., Mishawaka, Ind. * Layne-Louisiana Co., Lake Charles, La. * Louisiana Well Co., Monroe, La. * Layne-New York Co., New York City * Layne-Northwest Co., Milwaukee ,Wis. * Layne-Ohio Co., Columbus, Ohio * Layne-Pacific, Inc., Seattle, Washington * Layne-Texas Co., Houston Texas * Layne-Western Co., Kansas City, Mo. * Layne-Western Co. of Minnesota, Minneapolis, Minn. * International Water Supply Ltd., London, Ontario, Canada * Layne-Hispano Americana, S. A., Mexico, D. F.

X-ray generator, a rotating indexing holder for four specimens, a special collimating system, a crystal (usually sodium chloride), a goniometer having a scale from 0° to 90°, and a Geiger counter. Crystal and Geiger counter are mounted on and positioned by arms which traverse the goniometer arc.

The apparatus serves for determinations on elements ranging from atomic numbers 20-41 when a rock salt crystal is employed. For elements 42-50, a calcium fluoride crystal may be used.

21—Cleaner

Airetool Manufacturing Company, 316 S. Center Street, Springfield, Ohio, is now manufacturing a direct-drive cleaner weighing only 21 pounds which is designed for cleaning all scale conditions from condenser and heat exchanger tubes from ⅜ to 1½-inch i.d.

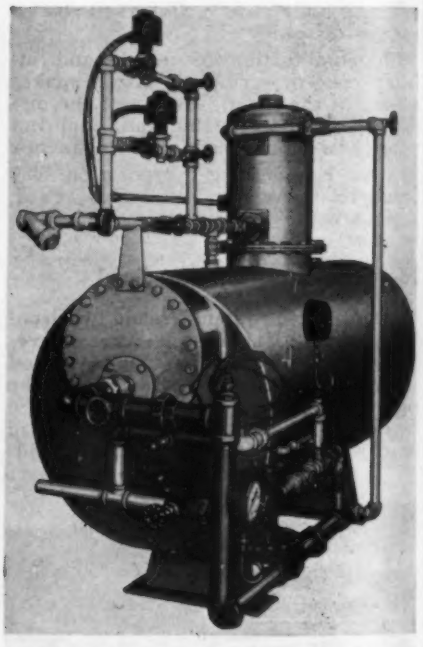


This model CC-450, which can be used with or without a supporting rig, is sturdy, lightweight aluminum alloy. All moving parts are made from alloy steel, heat-treated to insure uniform grain and hardness. The operator has constant, positive control and the direct drive, high speed motor is air or steam driven.

This cleaner also employs Airetool's featured slip-fit construction which permits quick disassembly. Various designs of cutters and drills are available for use with the cleaner.

22—Deareator Type Heater

Effective mechanical deareation of boiler feed water with oxygen reduction to less than .06 cc. per liter is announced by the Fred H. Schaub Engineering Company, Inc. 12110 S. Marshall Boulevard, Chicago 23, in its deareator type



feed water heater. The process consists of preheating above the boiling point of all feed water entering the receiver, and diffusing of the water under pressure through a series of spray nozzles.

Several variations of deareator system can be readily incorporated into any open type return system; sizes from 100 to 1000-horsepower rating are available. Corrosion resistant alloys reduce maintenance to the minimum, and automatic equipment includes guages, thermostats, and regulators along with the vent condenser and spray header. Ask for engineering bulletin S-350.

When writing the manufacturer of new equipment for literature or more information identify his product by name and number listed in Petroleum Refiner.

23—Large Thermoplastic Tubing

Thermoplastic tubing in diameters up to 10 inches is announced by Carter Products Corporation, 10225 Meech Avenue, Cleveland, Ohio. Such tubing is held to close tolerances of both inside and outside diameter and even larger diameters than 10 inches are possible where necessary.

The production of large diameter plastic tubing opens up many possibilities for users in various fields.

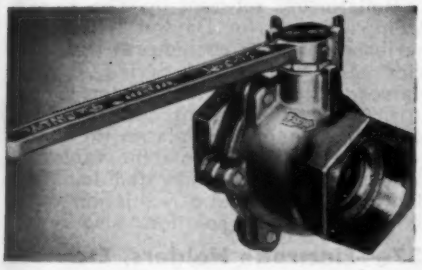
24—Permanent Valve Packing

A chemically inert, anti-adhesive, and easily deformable valve packing, "Chemiseal" No. 510 is available from United States Gasket Company, 610 North 10th, Camden, New Jersey. Fabricated from 100 percent unoriented teflon, the packing is inserted into valve stuffing boxes in the form of a sleeve or bushing and with low nut pressure flows to the dimensions of the stuffing box.

"Chemiseal" No. 510 does not require replacement; there is no freezing and binding of valve stems and reciprocating shafts, and minimum operating force is required on the spindle. It is available in a wide range of diameters and lengths.

25—Ball Type Valve

Rockwood Sprinkler Company, Worcester 5, Mass., has announced a new ball type valve which offers unrestricted, full flow, leak-proof service. The valve is constructed with a floating bronze ball that is hard chrome plated, making



it extremely resistant to scratching, pitting and abrasion. The valve has a full round port area which eliminates flow turbulence and reduces friction to a minimum. The valve is recommended for use in handling water, petroleum, gas, oil and many other types of liquids and gases.

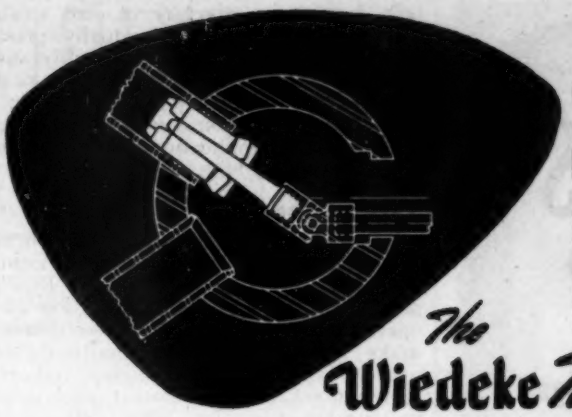
26—Water Columns and Gages

Yarnall-Waring Company, Mermaid Lane, Philadelphia 18, Pa., has issued a late edition of Bulletin WG-1811 on water columns and gages. The latest edition of the company magazine *Yarway News* containing technical information on compensation of boiler water level readings should be useful as engineering reference on boiler operation.

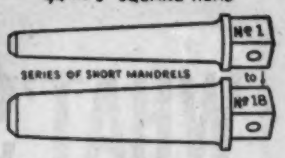
27—Clad Steel

A bulletin by Lukens Steel Company, Coatesville, Pa., describing the procedure followed in the manufacture of clad steels may be obtained upon request.

Whereas the backing plate may be of any ASME specification steel, according to requirements, the cladding usually is nickel, inconel, Monel, or stain-



3/4" or 1" SQUARE HEAD



Short mandrels are available in sets, to obtain full expansion range.

Expanders are made in a complete range of sizes, marked for the inside diameter they enter, from 1 1/8" through 3 1/8", progressing by sixteenths.

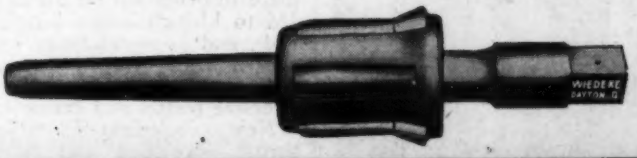
The Wiedeke New Improved

SERIES-1500 Ideal Tube Expanders

New and improved . . . for better efficiency The frame of the IDEAL Tube Expander has been shortened for easier entry into tube when rolling in small headers or other close quarters.

The mandrels and rolls are made of controlled-quality Alloy Tool Steel, carefully selected and heat treated . . . for dependable service.

For complete details, see your dealer, or write today for IDEAL Bulletin No. 65-B.



The Gustav Wiedeke Company

DAYTON 1, OHIO

FILTER UNITS by MULTI-METAL

The illustrated filter cylinder, made of stainless steel wire cloth over carbon steel skeleton, is one example of Multi-Metal's "know-how" in the design and fabrication of filter cloth assemblies. The versatile ability to produce such intricate units is a natural result of 35 years of specialization in the wire and filter cloth field. That is why Multi-Metal fabricated filter units are so widely used in the processing industries to speed up production, increase equipment life, cut maintenance expense, and protect product purity.

Multi-Metal stocks a large variety of filter and wire cloth of all meshes, weaves and metals supplied by the yard, piece or roll. Send for wire cloth samples and catalog describing Multi-Metal's complete fabricating facilities. Include your prints and specifications for prompt quotations.

More than 35 years of service to process industries

Multi-Metal

WIRE CLOTH COMPANY, INC.

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GET THIS BOOKLET—The Tube-Turn line of welding fittings is BIG, and still growing! This 20-page Supplement to TT Catalog No. 111 gives you data about important new items which, more than ever, make Tube Turns your *one source of supply for all welding fitting requirements.*

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less. In the manufacture of clad steels the components are individually processed to prepare them for assembly and precise control is exercised over the proportions of these components. The bulletin describes various types of cladding, procedure of application and Lukens' facilities for cladding.

28—"Capacilog"

The "Capacilog" is a new development described in Wheelco Instruments Company's Bulletin C2-1 (Wheelco Building, Chicago.) Modern construction and operational qualities of the instrument make it adaptable to a multitude of process applications requiring indicating, control and permanent record of measurable variables. This "electronic scriber" adds a power-driven pen recording function with an "electronic link" to measurement and control. It is offered in forty-two models, using either deflectional or null type measuring systems.

29—Air Cylinders

Miller Motor Company, 4027 N. Kedzie Avenue, Chicago 18, Illinois, has issued bulletin A-105 that supplies complete information on air cylinders from 1½ to 14-inch bores. Single and double rod end non-rotating cylinders are shown with or without cushions, and with a choice of standard and many oversize piston rod diameters.

New copyrighted tables showing thrust developed and consumption of cylinders, capacities and pressure losses in pipes and fittings, are included.

30—Pipe Line Equipment

A folder issued by M. J. Crose Manufacturing Company, Inc., 2715 Dawson Road, Tulsa, presents in easy reference form information and data on internal alignment clamps for pipe line welding (both hand-operated and electric) expanders, and portable power units.

31—Floor Material

Stonhard Company, 401 North Broad Street, Philadelphia 8, has published a folder describing Stonhard resurfacer, the heavy-duty material for repairs and overlays to concrete and wood floors. Illustrations show several typical installations and demonstrate the versatility of this material in solving floor problems.

32—Polyisobutylene Concentrate

A technical data sheet covering properties and applications of Arwax polyisobutylene concentrates has been prepared by American Resinous Chemicals Corporation, 103 Foster Street, Peabody, Mass. Told is the complete story of Arwax and its preparation for use in a wide range of industrial applications involving paraffin.

33—Boiler, Tank Accessories

Catalog 11 on forged boiler and tank accessories that gives complete buying information on manhole and handhole plates and yokes has been published by The Steel Improvement & Forge Company, 970 East 64th Street, Cleveland 14, Ohio. Shown are illustrations, dimensional drawings, tables of weights and sizes and descriptive information on manhole covers and yokes, handhole covers and yokes, welding street ells and water column ells. Comparable designations giving chemical propositions and tensile properties of the products as well as hydrostatic test data also are presented.

Requests for manufacturers' literature get prompt replies when you identify each item by number and name listed in Petroleum Refiner.

34—Stainless Electrodes

Bulletin 1047, entitled, "What Electrode to Use to Weld a Specified Stainless or Alloy Steeel," has been published recently by Arcos Corporation, 1515 Locust Street, Philadelphia 2. Provided is information on base metal identification of solid and clad materials, recommended types of electrodes, special considerations involving corrosion, heat or strength properties, as well as suggestions for welding dissimilar metals. Also included is a complete chart of the trade names of stainless alloys as produced by U. S. mills.

35—Metallurgical Bulletin

Tempil Corporation, 132 West 22nd Street, New York 11, has a bulletin, "Tempil Topics—Tips and Techniques in Temperature Control," which treats in brief form current problems in metallurgy and recommendations for their solution. References from which further information on the subject can be obtained also are listed.

Tempil also offers "Basic Guide to Ferrous Metallurgy," for definition and boundary of lower critical temperatures.

36—Corrosion-Resistant Valves

Bulletin 615 released by The Duriron Company, Inc., of Dayton 1, Ohio, describes Durco corrosion-resisting, Series 35 Y valves and Series 36 Angle valves and shows their internal construction by means of cutaway views. Complete dimension data on the various sizes are included. How the valves can be equipped with air operated diaphragm motors for automatic regulation of the flow of corrosive solutions also is told.

37—Electrode Holders, Etc.

Tweco Products Company, Wichita 1, Kansas, has issued bulletin 1948-T Twecolog, describing the complete line of Tweco welding electrode holders, ground clamps, cable connectors, machine terminals, cable splicers, lugs, and carbons holders. The bulletin also shows new models.

38—Stainless Fittings

Pittsburgh Piping and Equipment Company, 10 43rd Street, Pittsburgh, has published Catalog S-309 on stainless steel welding fittings which gives complete specifications and list prices of 2824 stock items in stainless types Nos. 304, 316, and 347. Included are standard fittings to match tubing and pipe of various wall thicknesses in various sizes from ¾ through 12 inches.

39—Thermocouple and Pyrometers

Bulletin P1235, covering thermocouples, protection tubes, and pyrometer accessories, has been published by The Bristol Company, Waterbury 91, Conn. Given are detailed drawings, complete information, and prices covering the accessories for pyrometers. It also contains a chart and valuable engineering data on selecting the right thermocouple and protection tube.

About EQUIPMENT SERVICE SUPPLIERS

Reynolds (left) and Croll

Croll and Reynolds Honored At Banquet in New York

Employes, company and factory executives and old friends of the company were present December 10 at a dinner in New York, given in honor of Samuel W. Croll and Philip E. Reynolds on the occasion of the 30th anniversary of the founding of the Croll-Reynolds Company.

Tribute was paid to two pioneers in the design and application of steam jet vacuum equipment under whose leadership the company has grown from a staff of two to an organization of more than 125, including production employes.

David H. Jackson, sales manager, toastmaster, enlisted the help of a dozen associates and friends of the company in presenting the story of the Croll-Reynolds organization.

Whenthoff Back To Texas

W. B. Whenthoff has returned to Houston and again is in charge of marketing the products of Tube Turns, Inc. in that area.

Whenthoff

Whenthoff's entire career has been devoted to the sale of industrial supplies and equipment in the West, Southwest, and Mexico. He became associated with Tube Turns, Inc. in 1937, when he opened the firm's Tulsa office. He established Tube Turns' Houston office in 1941.

Company Organized to Handle Dow's Saran-Line Fittings

Saran Lined Pipe Company, a newly organized firm, will be exclusive distributors for The Dow Chemical Company's recently developed specialty pipe and fittings.

Saran-lined pipe and fittings were developed for use where highly corrosive materials are handled in manufacturing processes. Chemical resistance, ease of fabrication, immediate delivery and reasonable cost are among the pertinent advantages of the new product, Dow reported.

S. H. Blackmore, sales manager of Saran-Lined Pipe Company, Stephenson, Building, Detroit, announced plans to establish sales representatives and jobber outlets throughout the country. The pipe and fittings are now in production at Dow's Midland plant.

New York Executives Named by International General Electric

Clement R. Tunell was named manager of the New York Divisions, and Clifford F. Storms, assistant manager of the New York Divisions, for International General Electric Company, Inc.

Tunnell, former assistant manager of the New York Divisions, completed his G-E test course in 1928 and joined the Apparatus Division, Schenectady, as commercial engineer. In 1931 he was transferred to the New York Divisions, and in 1934 he was made section head of those divisions.

Storms joined the New York office of the I.G.E. Company in 1944 as a sales engineer. In May, 1947, he was made manager, Utilities, Foreign Government Agencies, Consulting Engineers & Contractors Division, a position he held until his recent appointment.

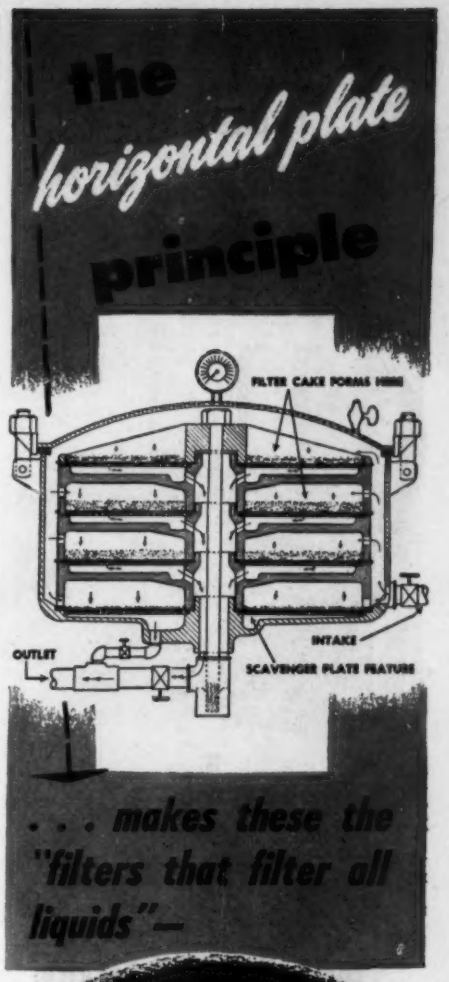
Pacific Pumps to Be Manufactured in England

Elmer J. Weis, vice president of Pacific Pumps Inc., Huntington Park, Calif. has completed an agreement with Pulsometer Engineering Co., Ltd., Reading, England, for the manufacture of the Pacific centrifugal line for distribution throughout Europe and the Near East.

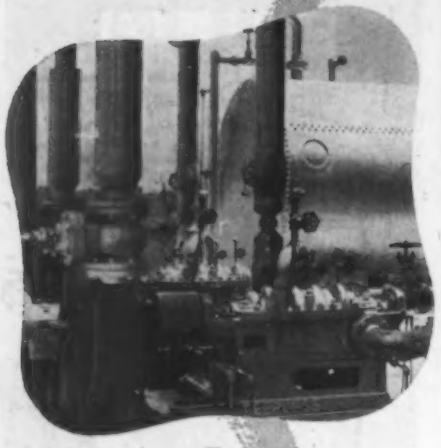
The British Company have the sole rights to manufacture the complete range of pumps which Pacific Pumps Inc., have for many years supplied for oil refineries and oil field services. The pumps and spare parts made at Reading will be interchangeable in every detail with those made in the U. S.

Ethyl Laboratories Observe 20th Anniversary in Detroit

Ceremonies marking the 20th anniversary of the establishment in Detroit of Ethyl Corporation's research laboratories were held early last month. Main speakers were Charles F. Kettering, for-


the horizontal plate principle
FILTER CAKE FORMS HERE
INTAKE
OUTLET
SCAVENGER PLATE FEATURE
. . . makes these the "filters that filter all liquids"—
SPARKLER
Horizontal Plate
FILTERS
. . . and here's the story:
• Sparkler Horizontal Plate Filters handle any liquid from heavy varnishes to light alcohols, including products such as acids, oils, beverages, milk, pharmaceuticals, plating solutions, water, etc.
• Equally efficient performance on intermittent or continuous operation, under a wide range of temperature, pressure and viscosity conditions.
• Equally effective whether removing carbons and contact clays or clarifying and polishing with filter aids.
• Patented Scavenger Plate permits complete batch filtration. (It's virtually an auxiliary filter with an independent control valve.)
• Unexcelled filter cake stability—no slipping or breaking.
. . . why?
Because filter media are supported on a horizontal plane and filter aids floated into position uniformly, filtration takes place uniformly over entire filtering areas. Flow through filter is always with gravity.
Sparkler Filtration Is Engineered Filtration—we invite correspondence on your problem. You will receive the advice of filtration scientists with a quarter of a century of experience in a specific field.
SPARKLER MANUFACTURING CO.
MUNDELEIN, ILLINOIS

ALL ALONG THE LINE THERE'S A
PEERLESS PUMP
TO MEET YOUR NEED



Peerless
TYPE TUT
Multi-Stage Pumps
for Boiler Feed Service

High efficiency is inherent in the design of the Peerless Type TUT Pumps. Built for heavy duty service the multi-stage TUT assures dependable operation in boiler feed water service as shown or in pumping other fluids in capacities up to 2500 g.p.m. against heads from 250 to 1000 feet. All types of drives available. Range of horsepower: 20 to 400 h.p.

FOR PUMPING CAUSTICS AND ACIDS ASK ABOUT PEERLESS TYPE ACO PROCESS PUMPS

Improved design has many advanced features for cutting corrosives pumping costs. Handles up to 800 g.p.m. against heads to 100 lbs.

REQUEST DESCRIPTIVE LITERATURE

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FOR MOST SERVICES IN ALL INDUSTRIES PEERLESS PUMP

PEERLESS PUMP DIVISION
Food Machinery Corporation

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American Brake Shoe's New Plant

American Brake Shoe Company's two new non-ferrous foundries recently completed at Niles, Ohio, and Meadville, Penn., were opened last month. The Meadville plant (above) replaces an older unit, will produce bronze bearings and castings. It will specialize in precision machine bearings for diesel engines and other high-speed and heavy duty service. The Meadville plant consists of a main foundry building, a two-story modern office building and a separate unit housing a heating plant. Constructed of concrete and brick, the main foundry has a total of 185,000 square feet of floor space. It also houses a machine shop. The two-story office building is approximately 200 feet in length and contains well-equipped locker and wash rooms as well as other facilities for employes. The new foundry at Niles, Ohio, will manufacture railroad journal bearings.

mer general manager of the Research Laboratories Division of General Motors and the first president of Ethyl Corporation back in 1924-25; Earle W. Webb, Ethyl board chairman and Kettering's successor as company president; and Edward L. Shea, president of Ethyl Corporation since Webb relinquished that office after 22 years to become board chairman last August.

Ethyl research covers a wide variety of fields, but the prime aim is to promote, through laboratory and road studies, the development of fuel additives and the fullest and most economical use of "Ethyl" brand of anti-knock compound. The Ethyl Laboratories also cooperate extensively with automotive and petroleum industries in continuous research designed to produce better engines and improved petroleum products.

Temperature Control Merger

The merger of Robertshaw Thermostat Company, of Youngwood, Penn., Fulton Sylphon Company, of Knoxville, Tenn., and the Bridgeport Thermostat Company, Inc., of Bridgeport, Conn., under the name of Robertshaw-Fulton Controls Company has been announced by John A. Robertshaw, president, of the new organization.

J. V. Giesler, president of Fulton Sylphon and Bridgeport Thermostat at the time of the merger, was elected executive vice president of the new firm, in charge of the Fulton Sylphon division, Knoxville, and Bridgeport Thermostat division, Bridgeport. T. T. Arden was elected executive vice president in charge of the Grayson Controls Division, Lynwood, Calif.

Whippo Succeeds Taggart

Ward C. Whippo has been appointed district sales manager for the Pittsburgh District of Reading-Pratt & Cady Division of American Chain & Cable Company, Inc., with headquarters at 908 Empire Building, Pittsburgh 22. Whippo, who has been with the company for 10 years, succeeds A. W. Taggart, retired.

Eiklor Now General Manager Of Harshaw Scientific

L. F. Eiklor has been appointed general manager of The Harshaw Scientific Division of The Harshaw Chemical Company in charge of all the division's activities both at the main office in Cleveland and in the various branches.

Eiklor

Eiklor, who studied chemistry at the University of Illinois, was, from 1916 to 1928, manager of the chemical department of Central Scientific Company at Chicago and later was manager of the fine chemical division of Pfaltz & Bauer, Inc. He also was connected for years with the General Chemical Company of New York and until recently he was with Philip A. Hunt and Company.

Leeds & Northrup Buys Building in Germantown

Purchase of the two-story and basement building at 34 E. Logan Street, one block from its main plant has been announced by Leeds & Northrup Company. The newly acquired property will add 11,000 square feet of floor space to the 288,886 square feet now in use at the Leeds & Northrup plant on Stenton Avenue.

The building will be adapted as quickly as possible, officials said.

Oilwell Announces Changes

Changes in Oil Well Supply Company personnel have been announced as follows:

Wayne B. Atkins, manager of the McCamey, Texas, store has been appointed manager of the Big Spring, Texas, store. He is succeeded at McCamey by Joseph M. Rogers, transfer-

red from Denver City, Texas, where he held a similar position.

Carroll R. Jones, city representative at Midland, Texas, has been named manager of Oilwell's store at Wichita Falls, Texas.

At Albany, Texas, Lloyd H. Fielder, who has been manager there, has been appointed assistant district engineer, subsurface equipment, with headquarters at Albany. His successor is M. F. Wellman, storeman in the Albany store.

Headquarters of C. R. Evans, district engineer, refinery and pipe line equipment, have been moved from Big Spring to Odessa, Texas.

Blackmer Representatives Expand

The Blackmer Pump Company, Grand Rapids, has announced that its Ohio sales representative, William Berrington & Son, Inc., has purchased an additional 7000 square feet of warehouse space in Cleveland.

This addition, which is to be used to house a complete stock of Blackmer pumping equipment, is the third addition to Berrington facilities this year.

It is also announced that the Berrington sales territory has been increased and now includes approximately all of the state of Ohio, southern Indiana, and northern Kentucky.

Three Key Appointments At The Vapor Recovery Systems

Curfew

Lee

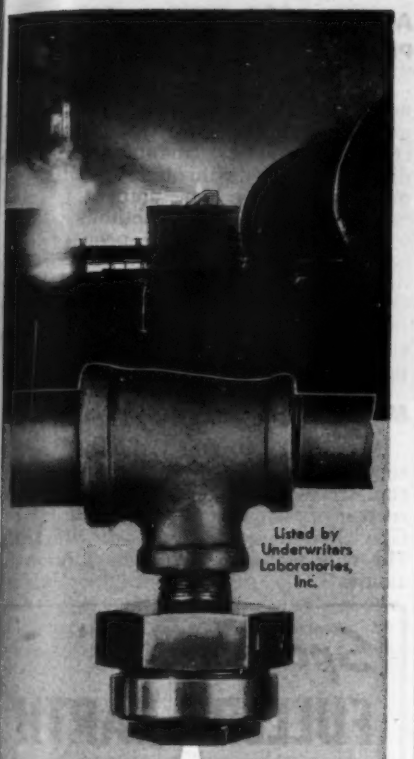
L. S. Curfew has been named executive vice president, Joseph F. Lee, general manager, and George F. Denny chief engineer effective January 1, 1948 of The Vapor Recovery Systems Company.

Denny

Curfew has been with Vapor Recovery since its inception in 1928 and has progressively advanced through several positions.

Lee, former chief engineer, served as chief machinery engineer with the California Shipbuilding Corporation during the war and prior to that, was with the Design Section, Bureau of Engineering, U. S. Navy for 12 years.

Denny was a former development engineer with The Vapor Recovery Systems Company. He too served in an engineering capacity with California Shipbuilding Corporation during the war and before that, spent 13 years with the Refining Department of The Texas Company.



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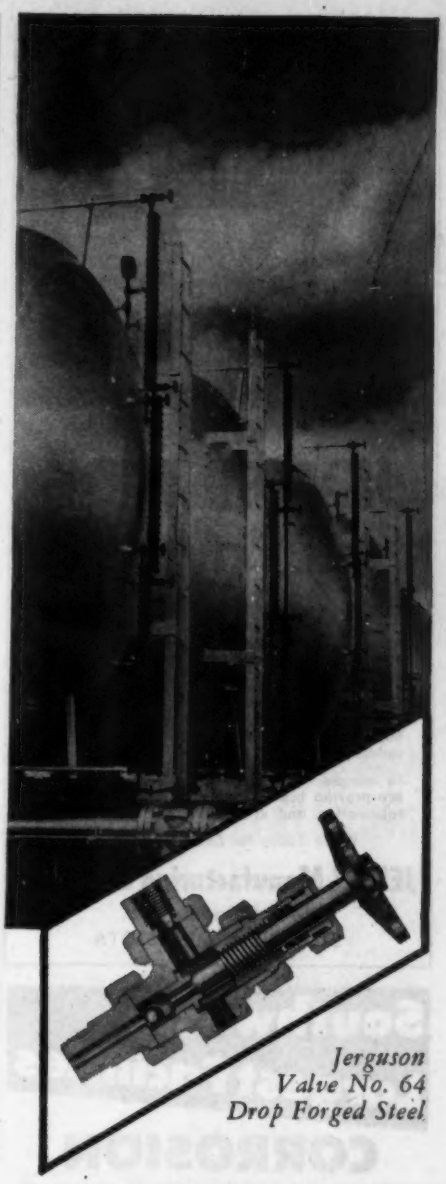

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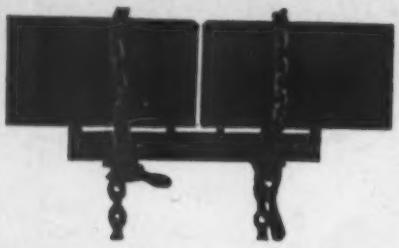

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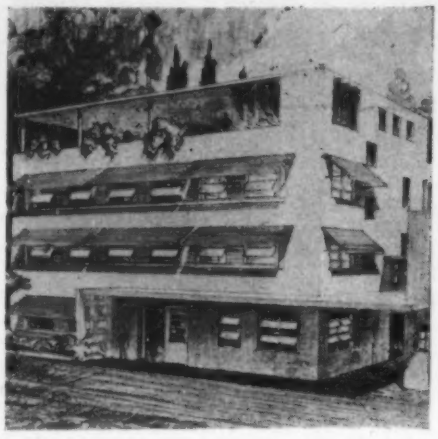
New Beckman Plant



National Technical Laboratories, manufacturers of Beckman control equipment, has recently completed an addition to its modern offices and plant in South Pasadena, Calif. The new addition, a Class A reinforced concrete structure is four stories high with a floor space in excess of 27,000 square feet. This new building, plus space in the original building at the main plant and two other plants in South Pasadena, provides approximately 60,000 square feet of floor space devoted to the development and manufacture of the various Beckman instruments. All production departments and production and purchasing offices, including final assembly operations on Beckman pH Meters and spectrophotometers, are located in the new building.

International Nickel Company Lists Year-End Promotions

Ralph D. Parker and J. Roy Gordon, of Copper Cliff, Ontario, and Herbert G. Fales, of New York, have been elected assistant vice presidents of The International Nickel Company of Canada, Limited and Walter C. Kerrigan, James F. McNamara and T. H. Wickenden have been named vice presidents of the company's United States subsidiary, The International Nickel Company, Inc.

All of these officials have long service with the company, McNamara's dating back to 1911, Wickenden's to 1922 and Kerrigan's to 1930. Parker will continue as general superintendent at Copper Cliff, Ontario. Fales will continue as a vice president and director of The International Nickel Company, Inc.

Expansion Program Announced By Allis-Chalmers Company

A drive to hire 1540 men and build night shifts of Allis-Chalmers Manufacturing Company, West Allis works, to a record peacetime high has been announced. With an order backlog in the company's general machinery division alone of more than $166 million, the total appropriations for buildings, machine tools and other equipment, shop re-arrangement and modernization at the West Allis works add up to $14,800,000. More than $8,800,000 of this amount has been spent and most of the remainder will be spent by the end of 1948, officials declared.

Manpower requirements which the company seeks to satisfy are based on the operation of all machines on a three-shift program wherever practical.

Air Reduction Expands Process Engineering Activities

Air Reduction Company has announced an expansion of its process engineering facilities for the purpose of reducing chemical manufacturing and distribution costs through an intensified program for the development of more economical plants and methods.

The newly expanded process engineering group will concentrate its immediate activities on "the development and application of new and improved processes for the manufacture of the company's existing line of chemical products."

Morse Joins Laclede-Christy

Arthur B. Morse, California refractory executive effective December 1, became a vice president and assistant director of sales of the Laclede-Christy Clay Products Company of St. Louis. He will make his headquarters in St. Louis.

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Gruitch Now With ACF

American Car and Foundry Company has appointed Jerry M. Gruitch director of research and development as of December 1.

Gruitch

Mr. Gruitch who has had a long and successful career in the field of engineering and research, holds the degree of B.S.M.E. from the University of Michigan and M.M.E. from the Chrysler Institute of Engineering. He is also a registered professional engineer and a member of Tau Beta Pi, Society of Automotive Engineers, American Society of Refrigerating Engineers and The American Society of Heating and Ventilating Engineers.

Following his separation from the Air Forces (colonel and Air Ordnance and Armament Officer on General Doolittle's staff at Okinawa) Gruitch was assistant chief engineer at the Dodge Division, Chrysler Corporation, on the design and development of power plants and accessories, and later, vice president in charge of engineering. He was a member of the board of directors, O. A. Sutton Corporation, Wichita, Kansas, prior to joining the ACF.

Patterson Appoints Dilg

Earl W. Dilg has been appointed district manager of Patterson Foundry & Machine Company, of East Liverpool, Ohio, with headquarters in Cincinnati. Dilg formerly was chief engineer and sales manager of International Engineering, Inc., of Dayton, Ohio, and later general manager of The Gem City Engineering Company of Dayton, Ohio.

Dilg

Christmas Bonus

Maintenance Engineering Corporationtion, Houston, issued Christmas bonuses totaling $24,000 to 80 employes, C. E. Naylor, president, announced. The bonus was based on $6 per month of service with the company with a minimum of $60 and a maximum of $600. Twenty-nine employes received the maximum bonus.

Naylor in December retired as president of the Houston Chamber of Commerce after serving a year and a half in that position.

Du Pont Changes

J. W. McCoy last month retired as a vice president and member of the executive committee of E. I. du Pont de Nemours & Company. He will continue to serve as a director.

William H. Ward, general manager of the company's explosives department, had been elected a director, vice president, and member of the executive committee. The changes become effective January 1.

Samuel G. Baker effective the same date became general manager of Du Pont's electrochemicals department. He has been assistant general manager of the department and will succeed F. S. MacGregor who is retiring after 31 years service.

Kerotest Appoints Adams

E. T. "Kink" Adams has been named director of purchases of Kerotest Manufacturing Company, the appointment being effective December 15.

Adams has been foreign representative for Kerotest and for 12 years had been purchasing agent of Sinclair Oil Company in Mexico. Prior to that time, he had been in the material department of Standard Oil Company of Venezuela.

R-S Special Conferences

To inform its valve division representatives of the products and developments of its newly established electronic division, R-S Products Corporation recently held special conferences in Chicago, and Philadelphia, Pa.

A new product of the electronic division is a unit for the control of fluid level, pressure and temperature, called the "Leveltronic," or level control.

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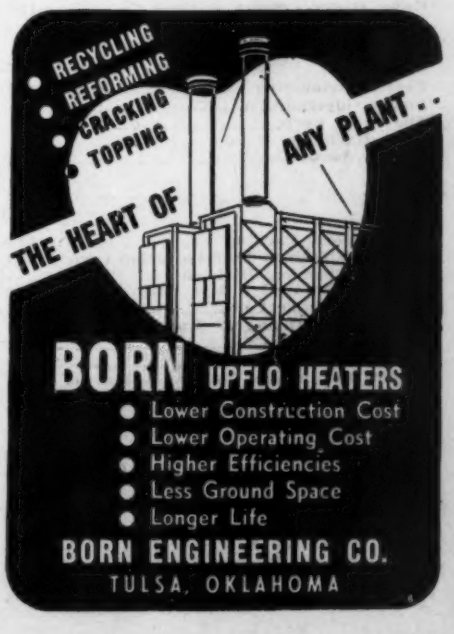

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